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Ko et al.

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(54) **AR PROCESSING DEVICE, AUGMENTED REALITY-BASED ROUTE GUIDANCE METHOD AND ELECTRONIC DEVICE**

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Jul. 30, 2021 (KR) 10-2021-0100694

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G06K 9/00 (2022.01)
G06V 20/56 (2022.01)

(52) **U.S. Cl.**

CPC **G01C 21/365** (2013.01); **G01C 21/3602** (2013.01); **G01C 21/3632** (2013.01); **G01C 21/3647** (2013.01); **G01C 21/3658** (2013.01); **G06V 20/588** (2022.01)

(58) **Field of Classification Search**

None
See application file for complete search history.

(57) **ABSTRACT**

An augmented reality (AR)-based route guidance method includes acquiring a driving image captured by an image capturing device of a vehicle which is running, acquiring route data to a destination of the vehicle, recognizing both side lane markings of a lane in which the vehicle is running from the acquired driving image, generating first route guidance linear data based on the recognized both side lane markings for a region in which both side lane markings are recognized in the driving image, generating second route guidance linear data using link linear data of the route data for a region in which both side lane markings are not recognized in the driving image, combining the first route guidance linear data and the second route guidance linear data to generate combined route guidance linear data, and displaying a route guidance object in AR using the generated combined route guidance linear data.

19 Claims, 21 Drawing Sheets

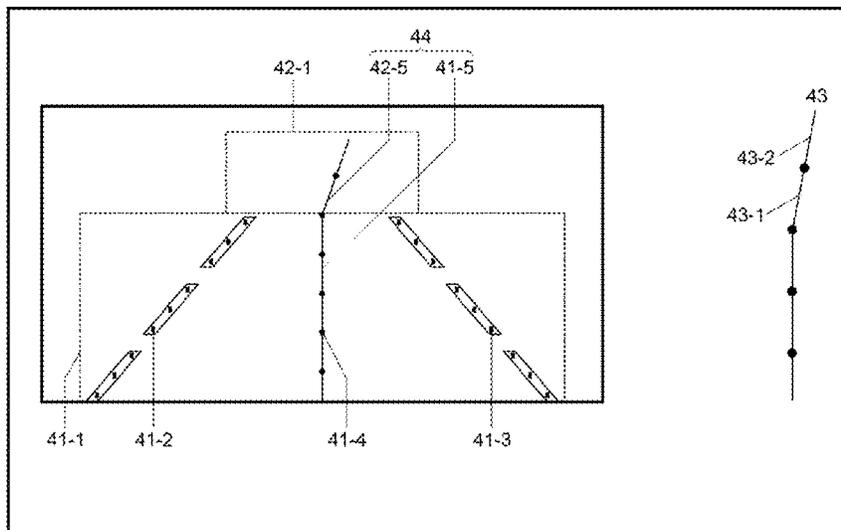


FIG. 1

10

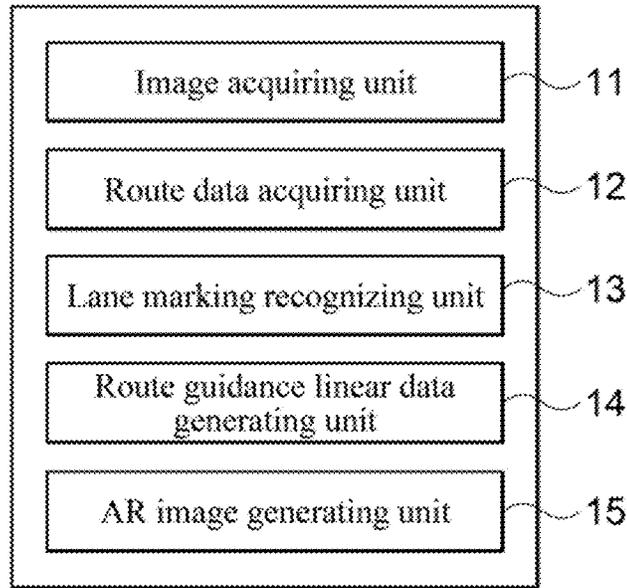


FIG. 2

15

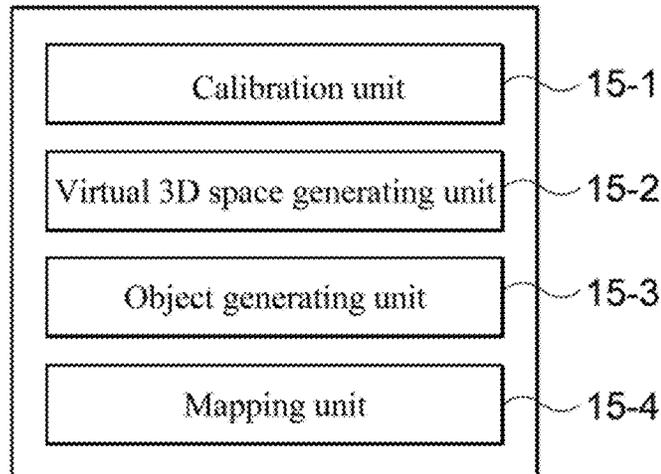


FIG. 3

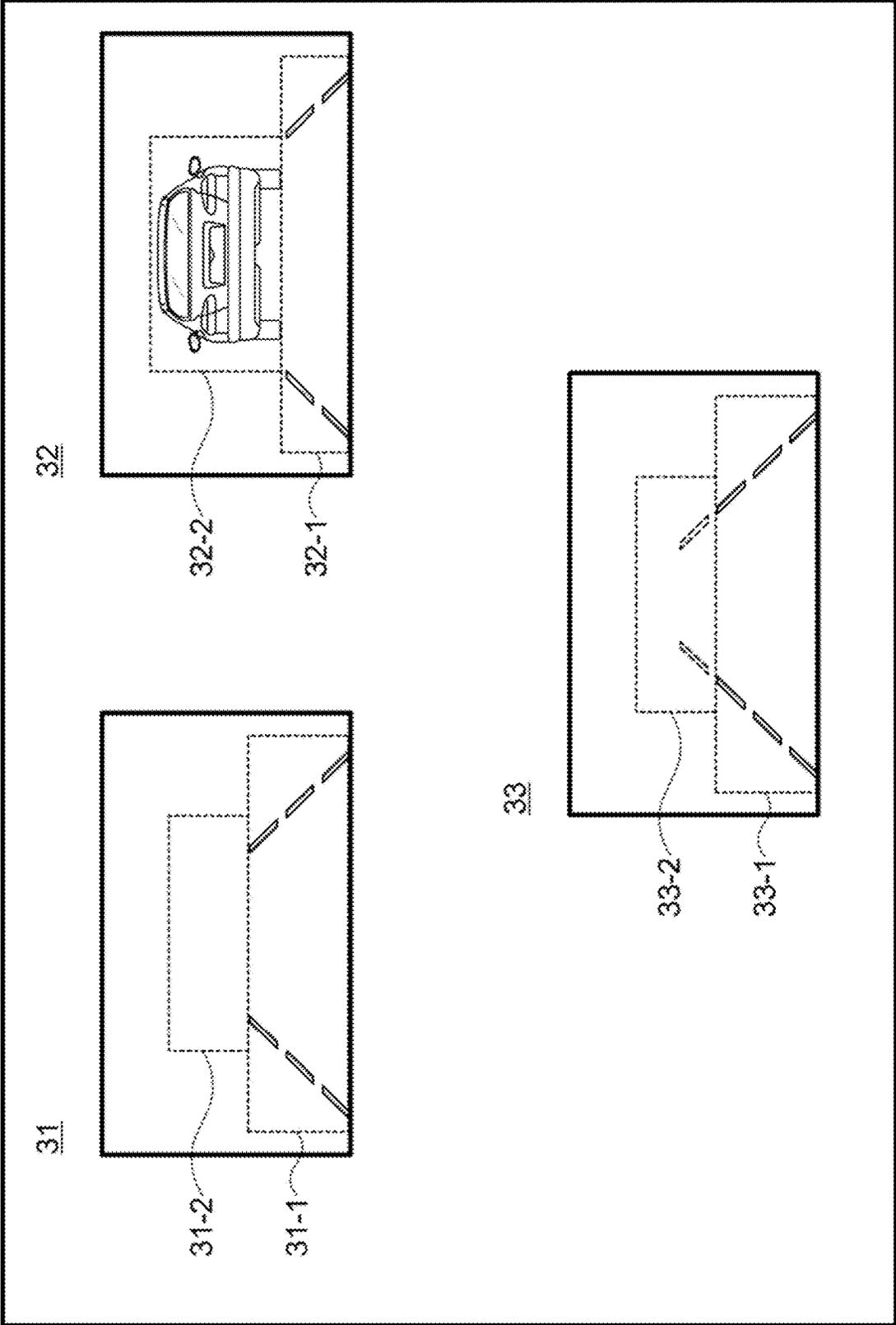


FIG. 5

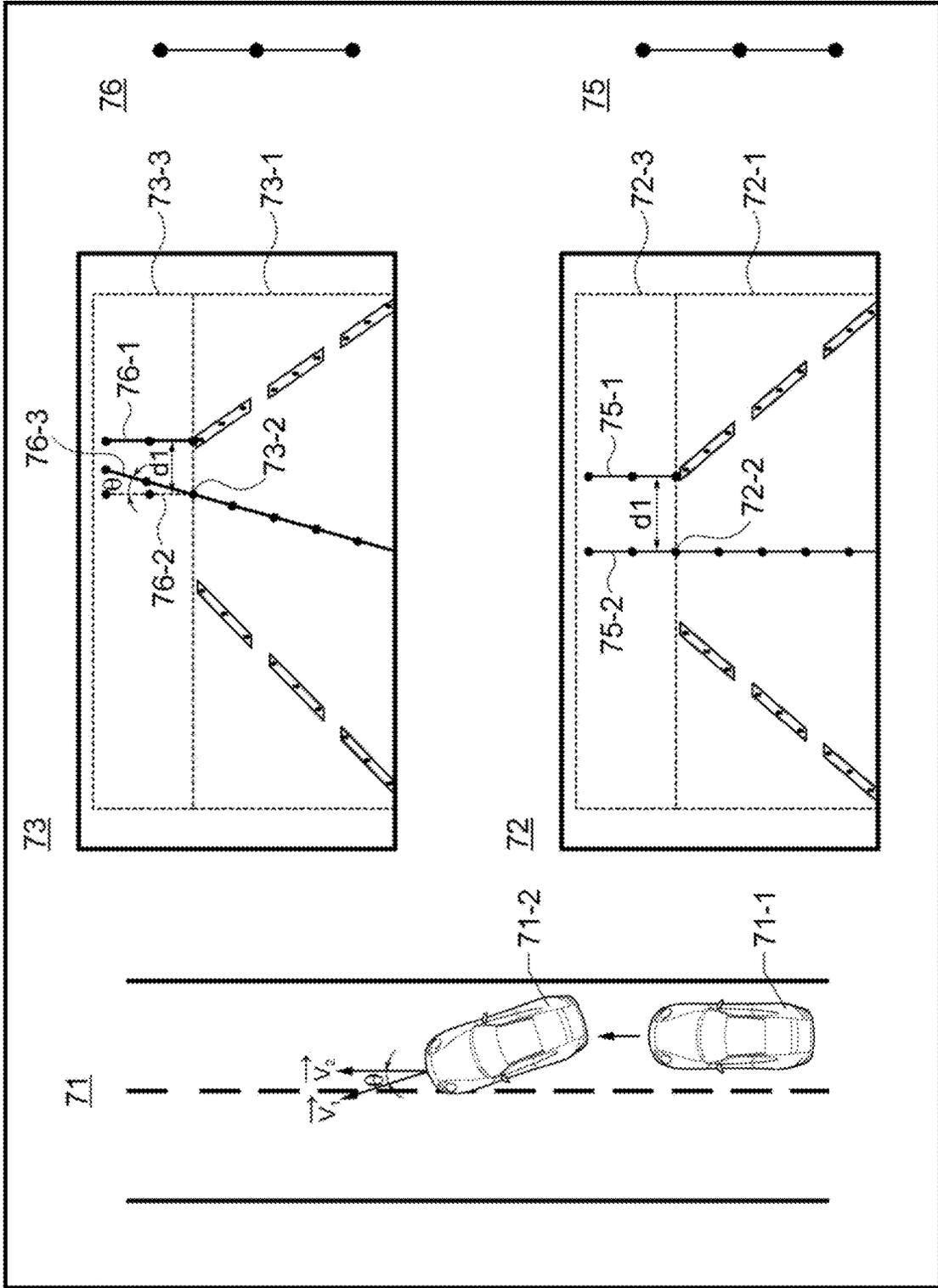


FIG. 6

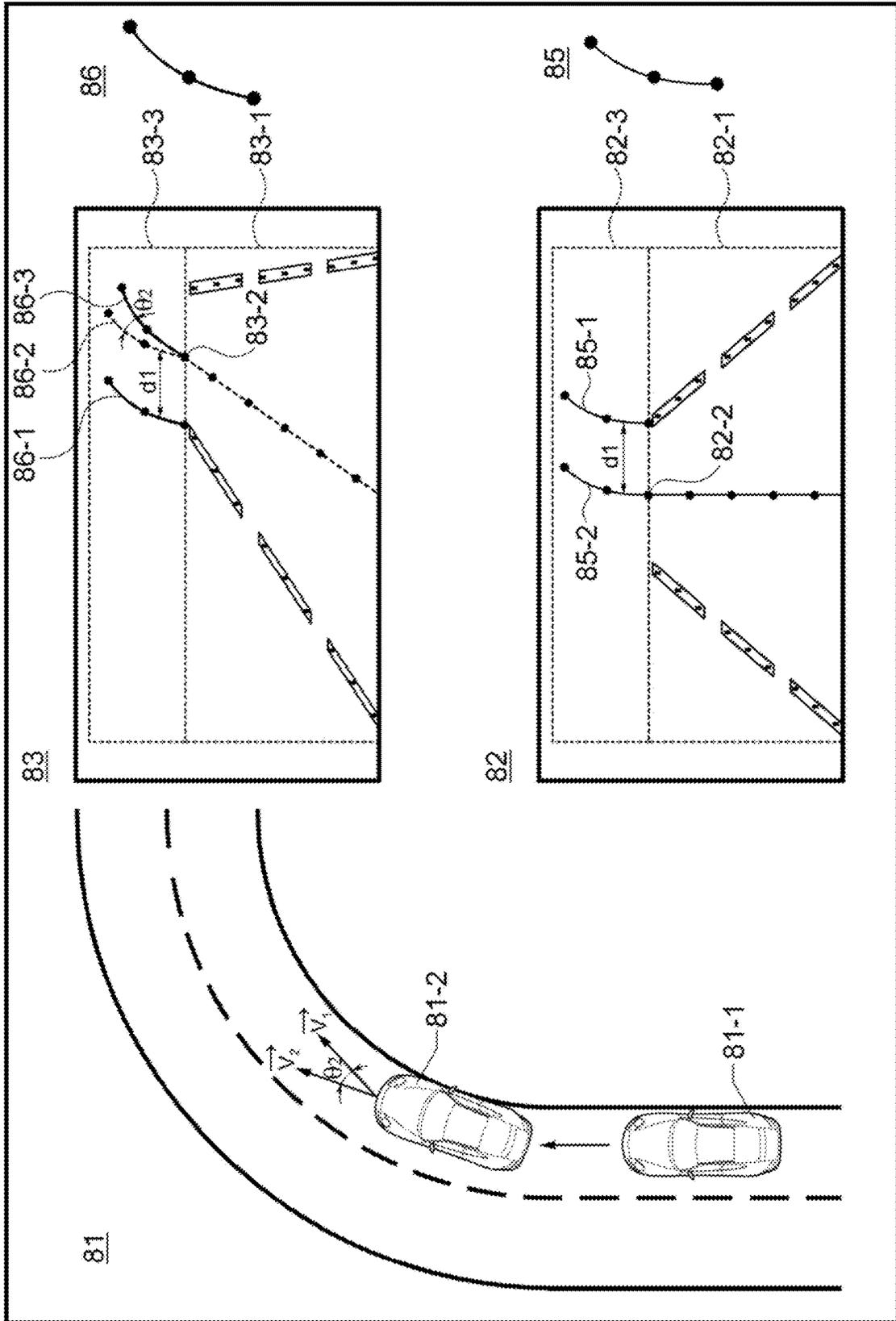


FIG. 7A

$$s \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} f_x & \text{skew}_{cf_x} & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{bmatrix} \begin{bmatrix} t_1 \\ t_2 \\ t_3 \\ 1 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix}$$

603
602
601
605

FIG. 7B

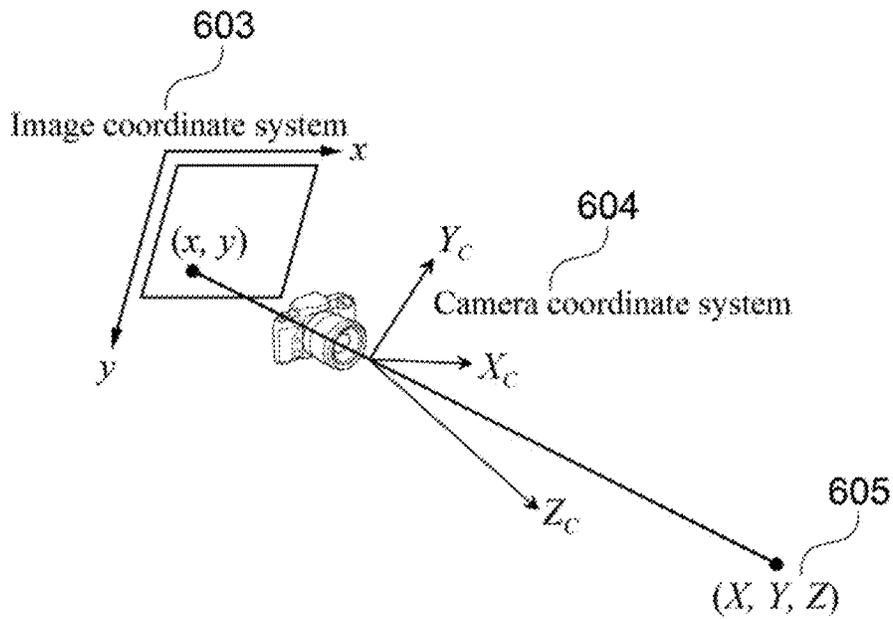


FIG. 8

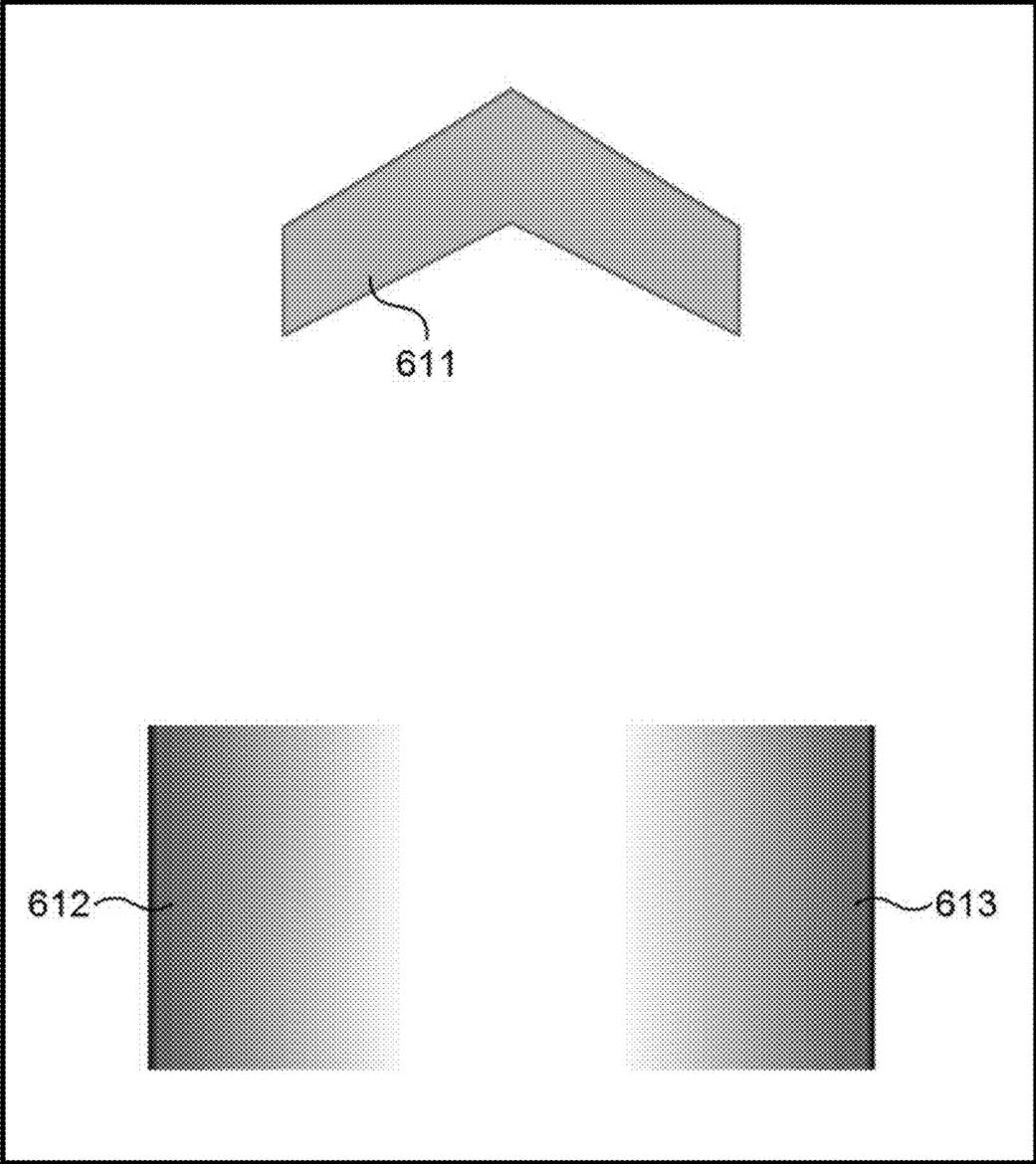


FIG. 9

20

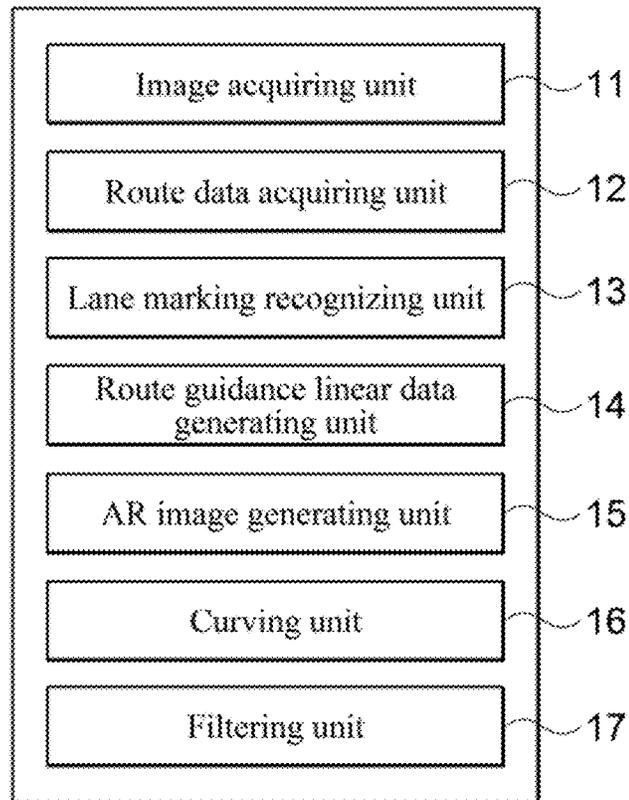


FIG. 10

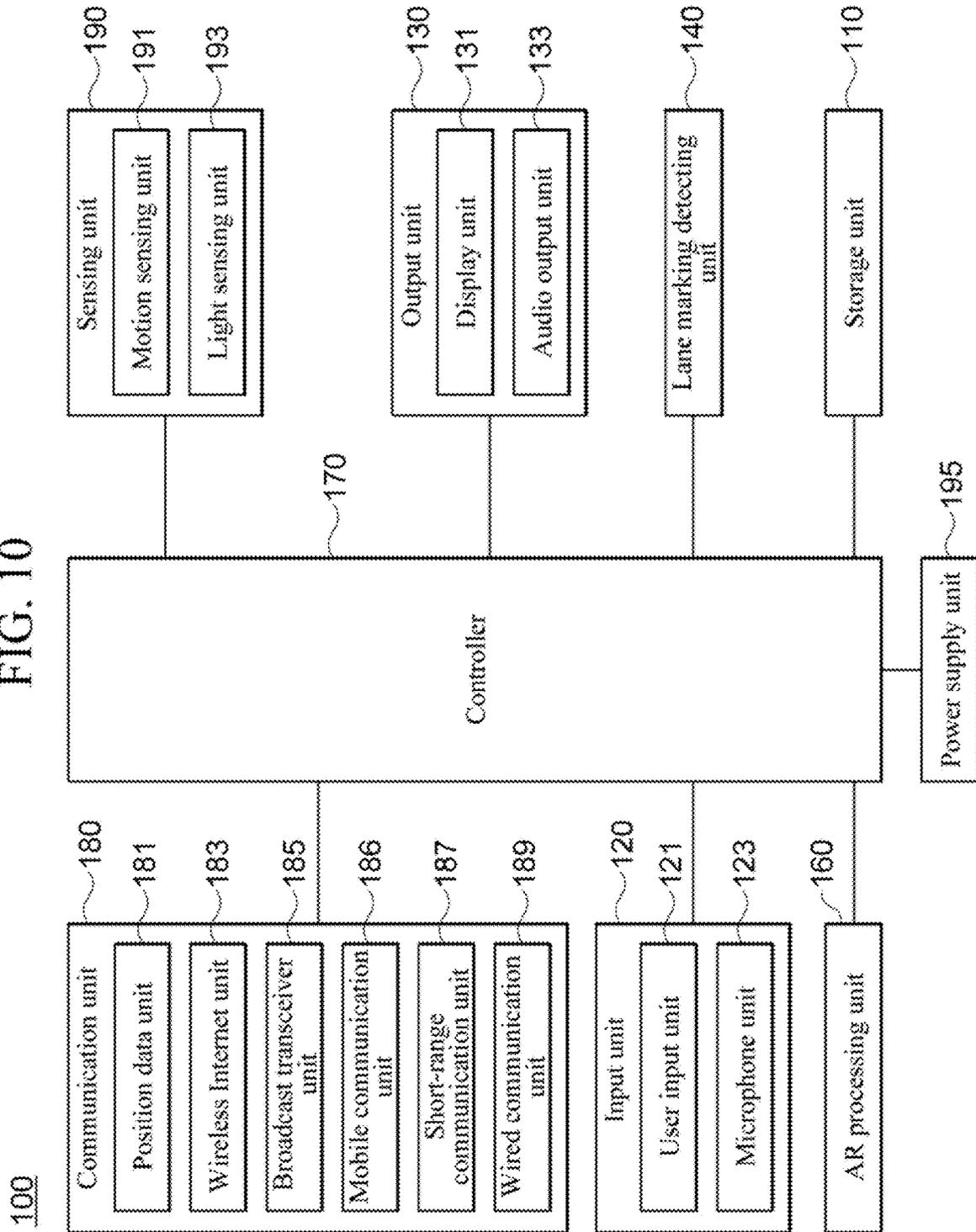


FIG. 11

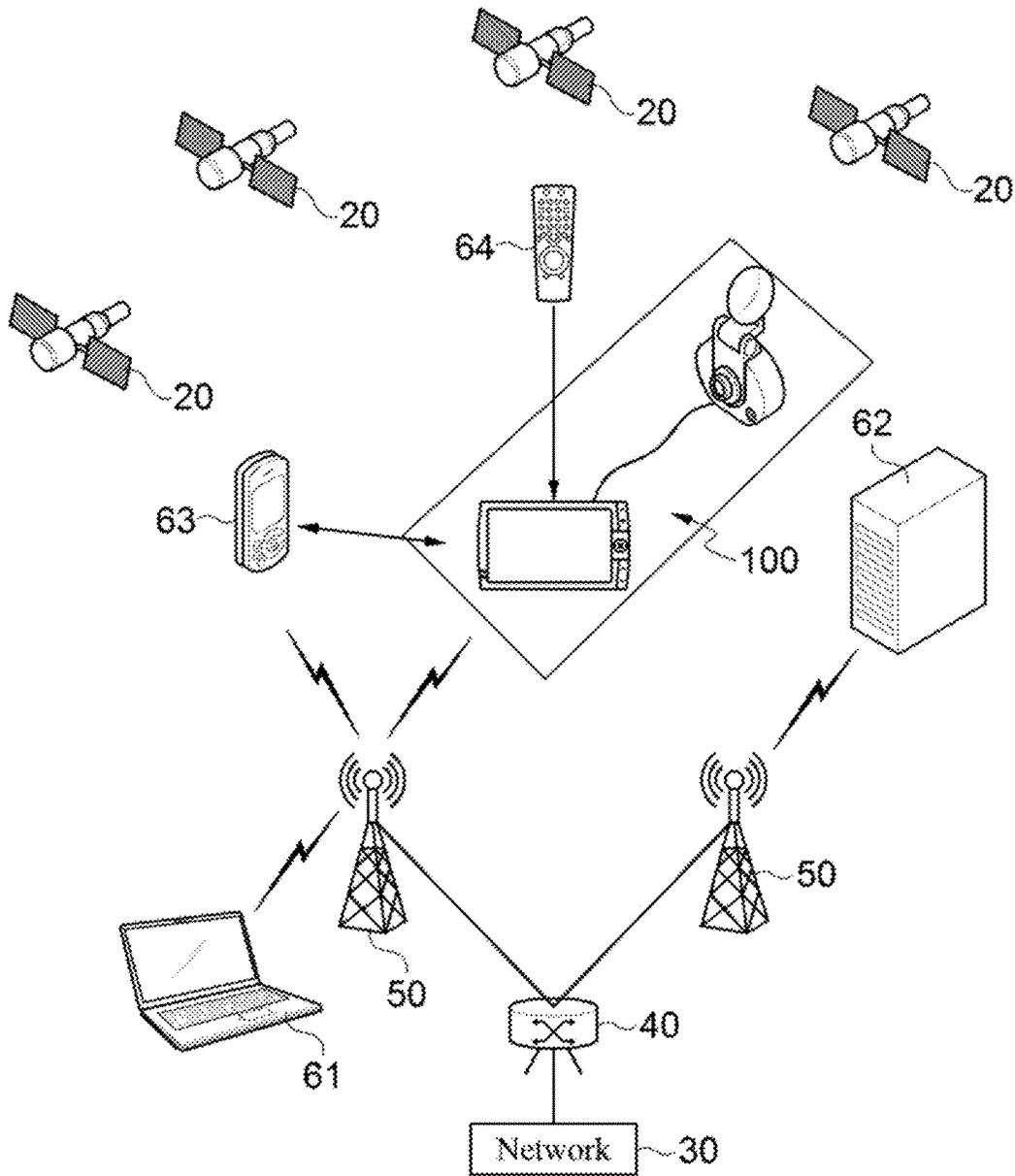


FIG. 12

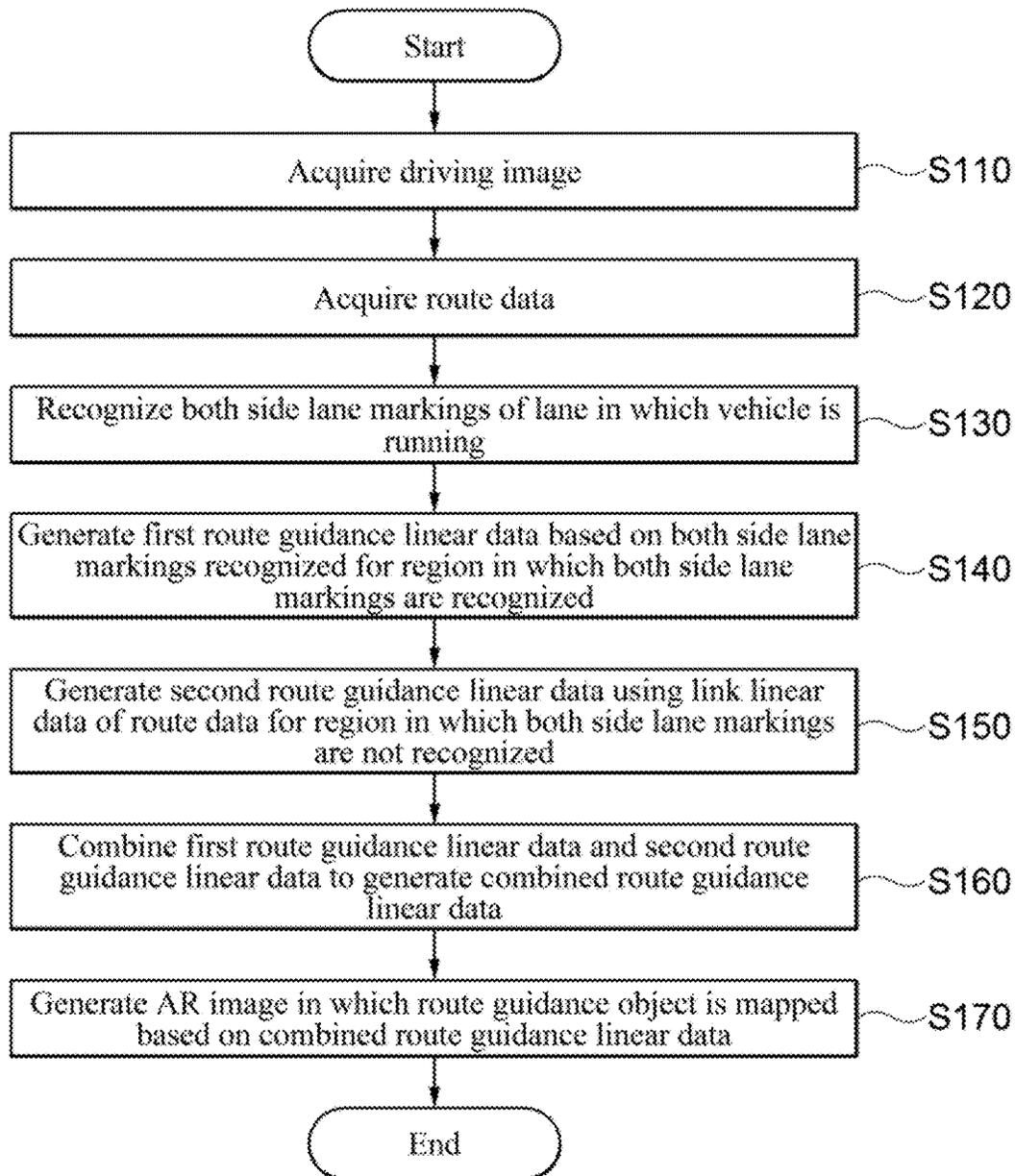


FIG. 13

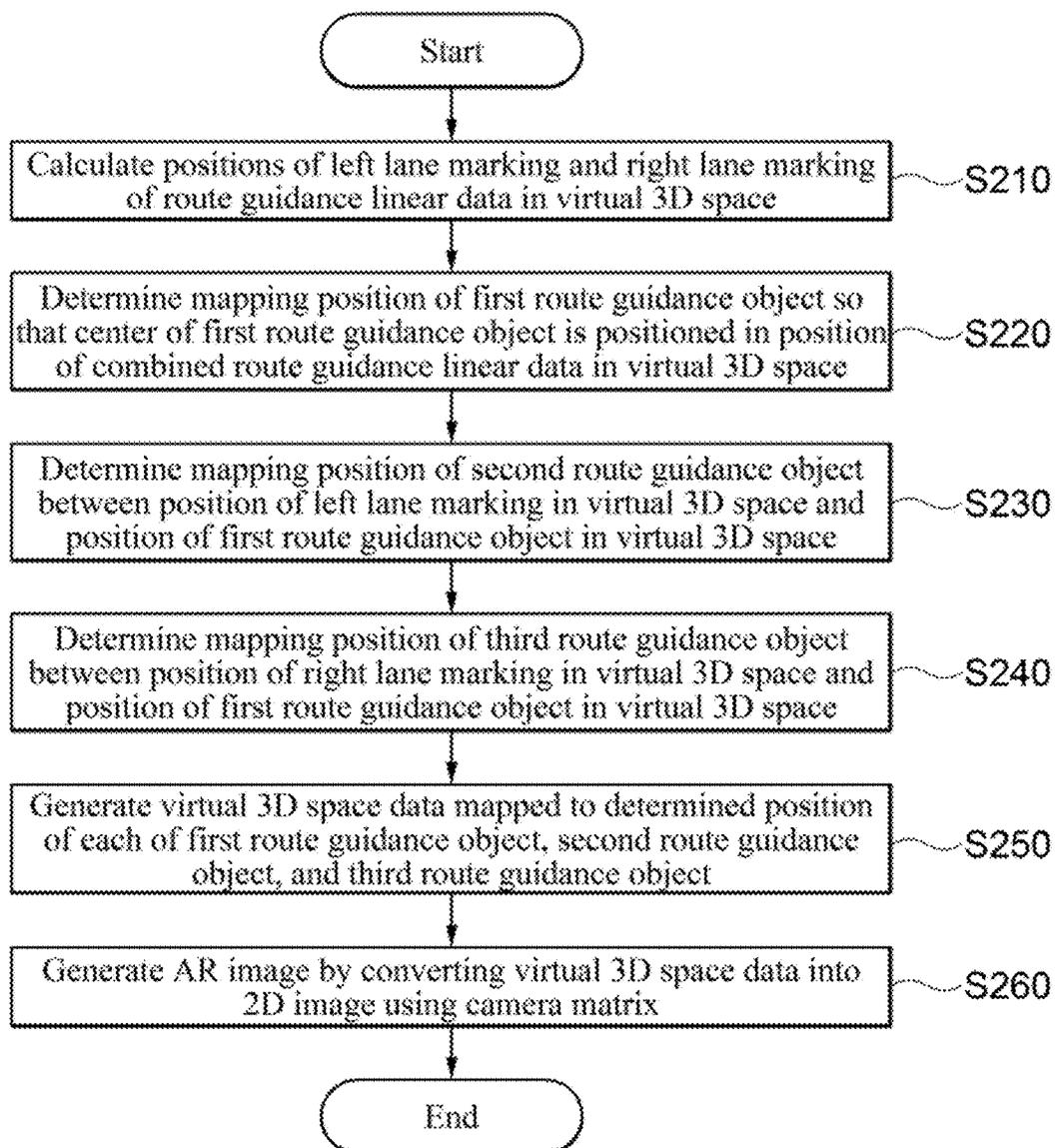


FIG. 14

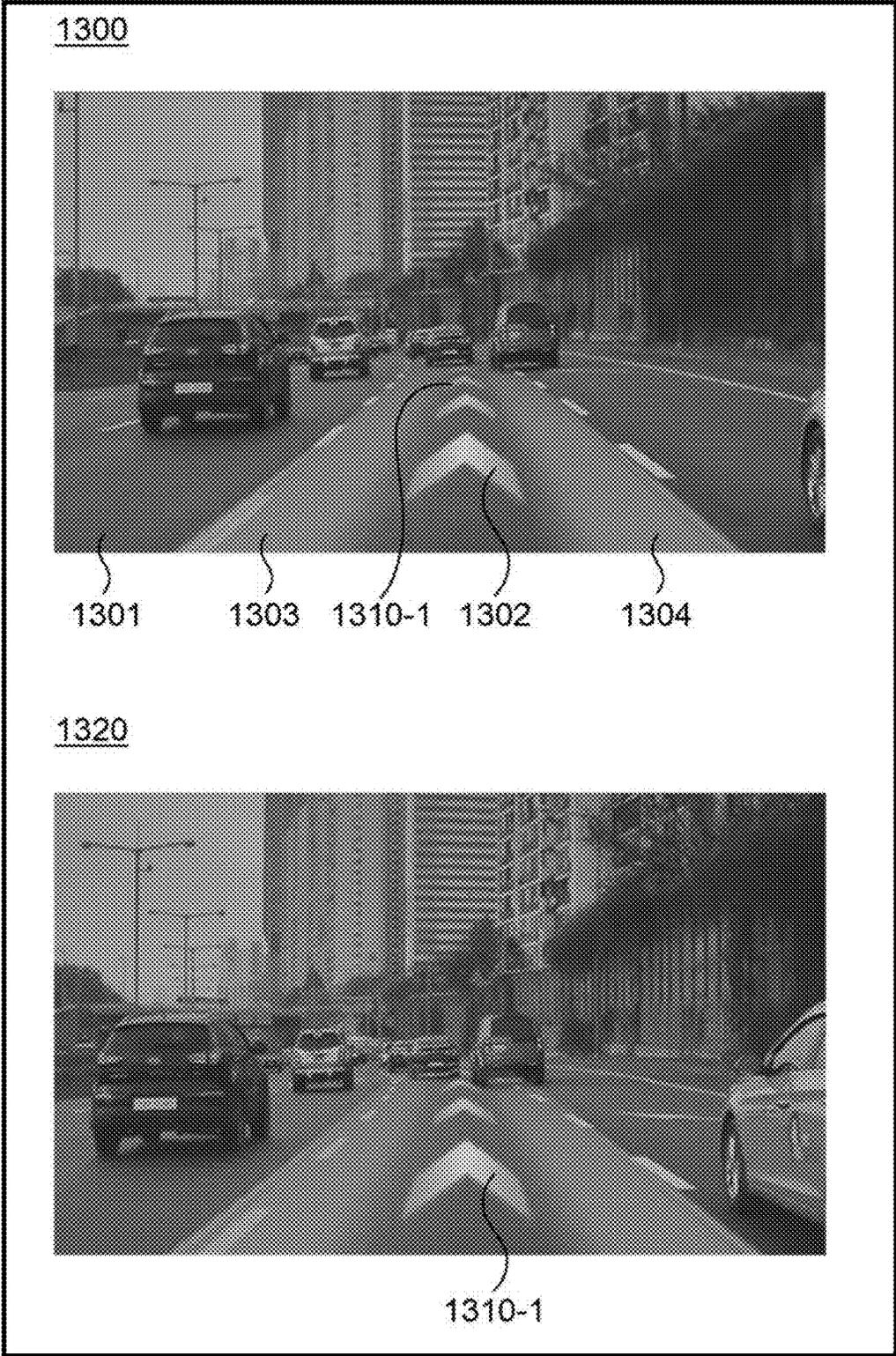
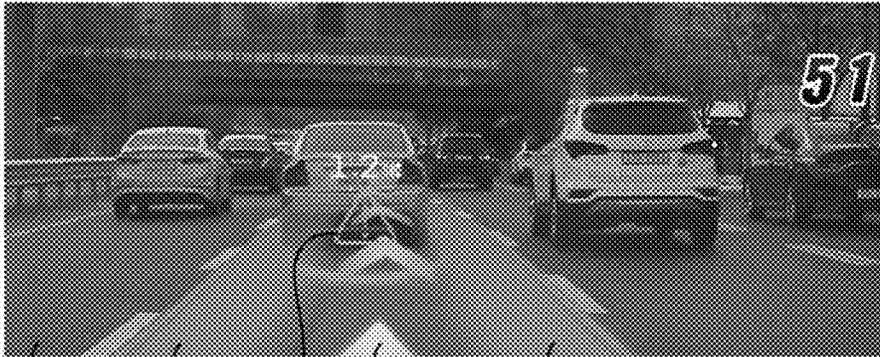


FIG. 15

1410



1401

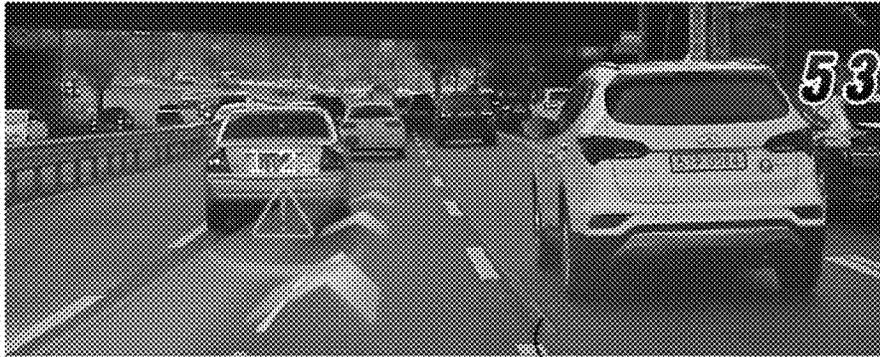
1403

1405

1402

1404

1420



1406

FIG. 16

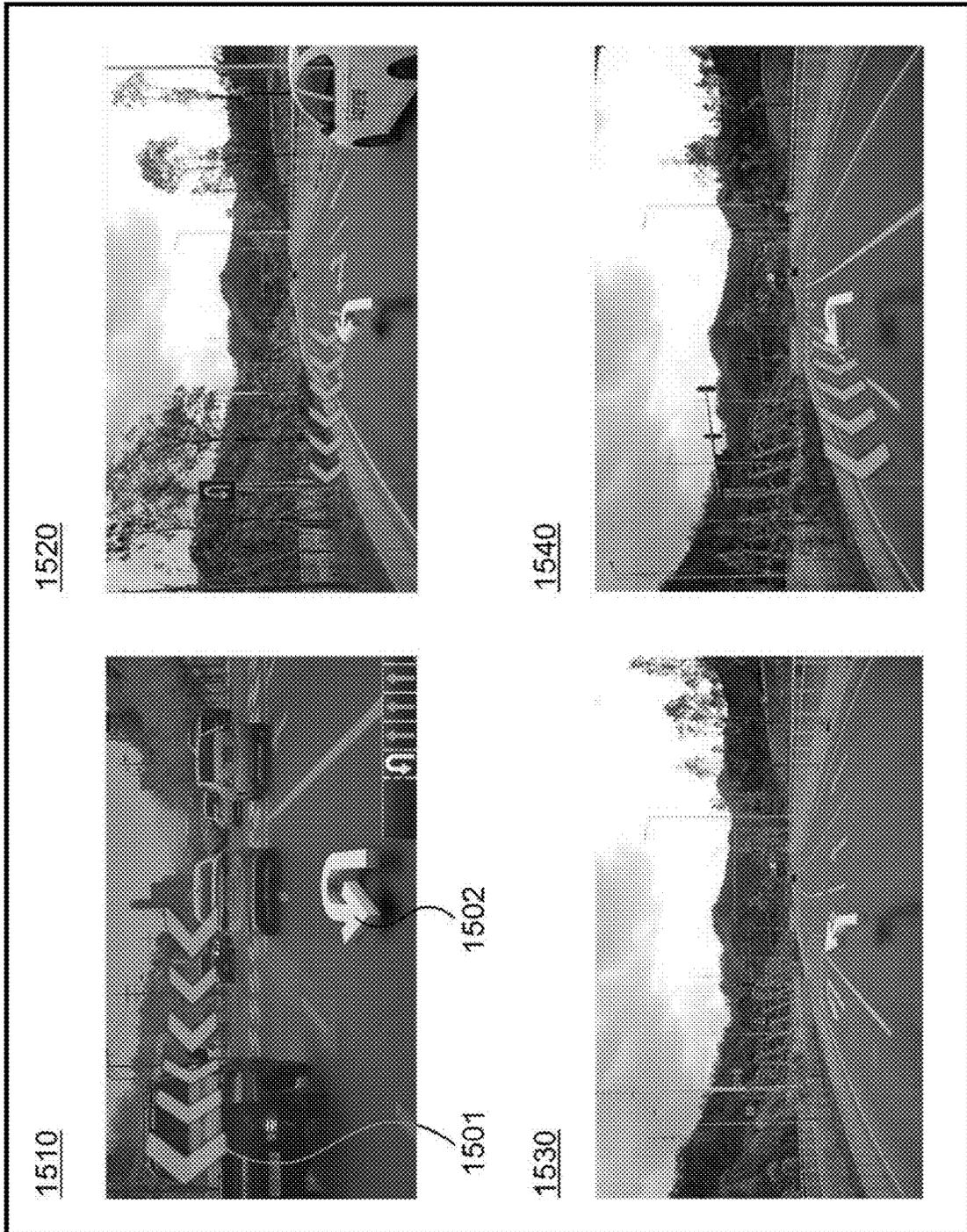


FIG. 17

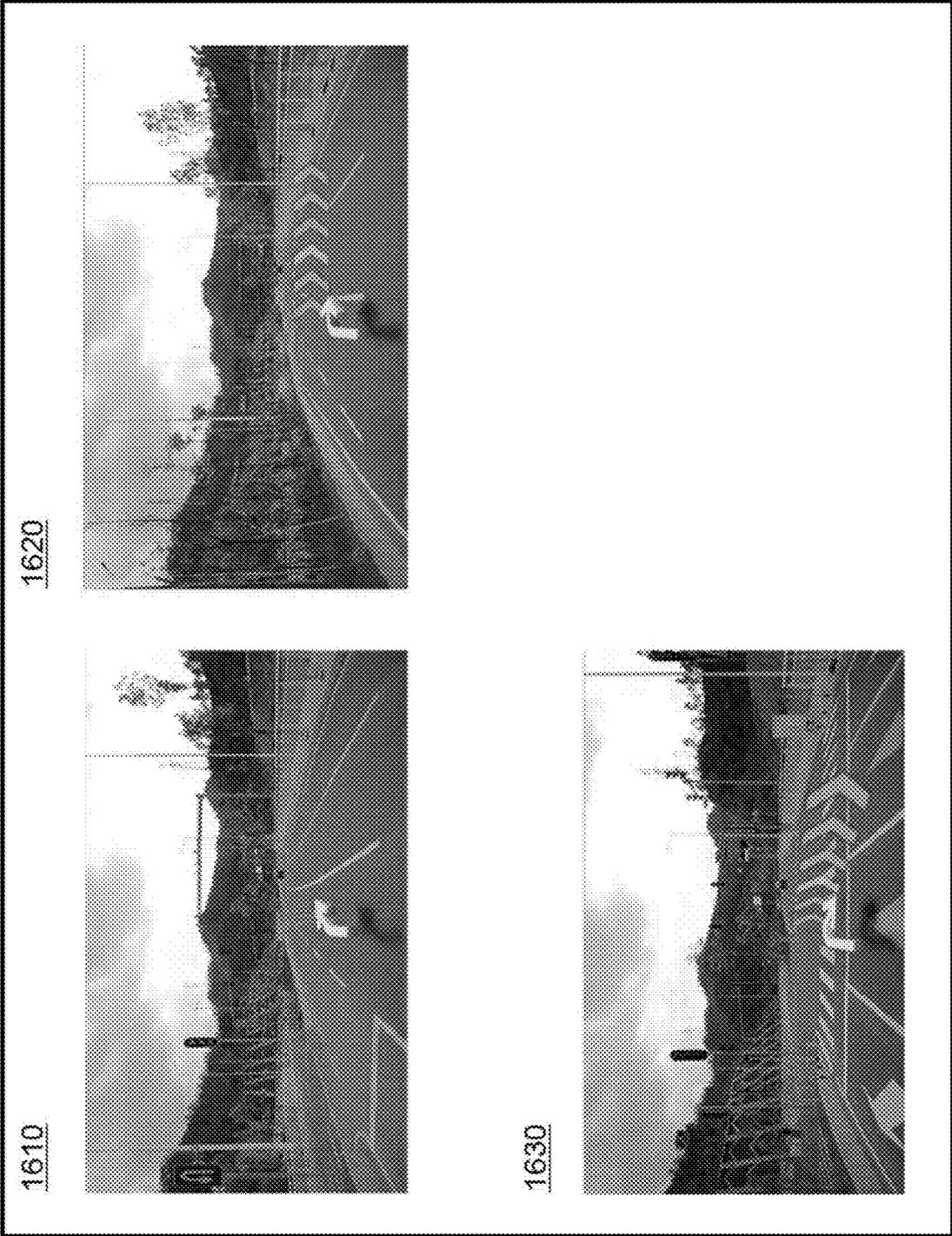


FIG. 18

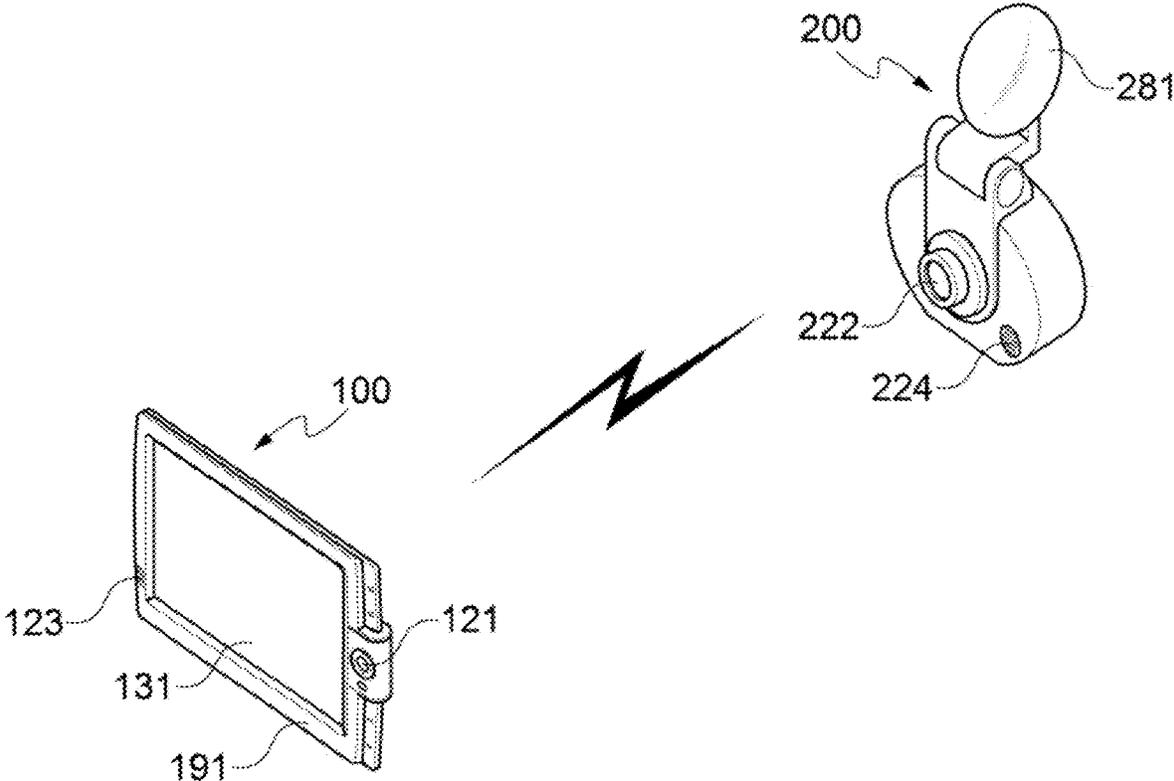


FIG. 19

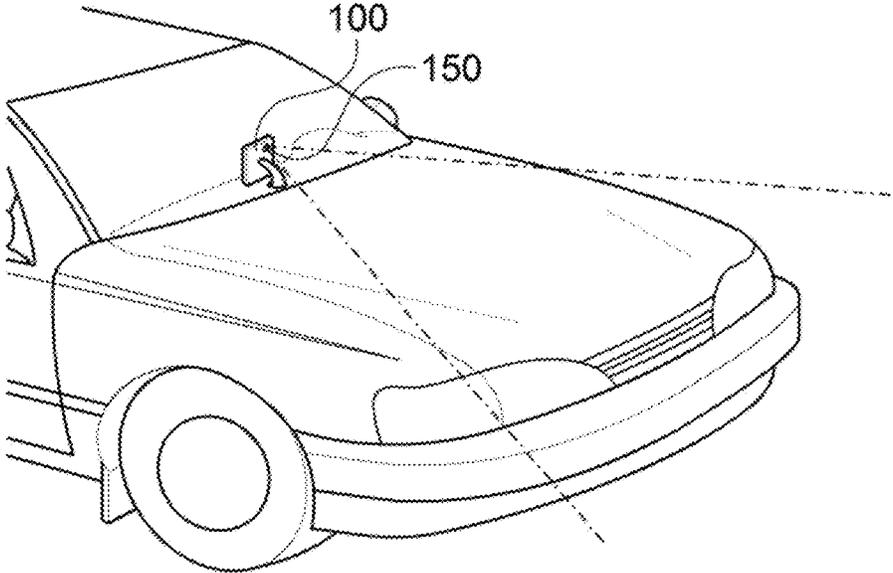


FIG. 20

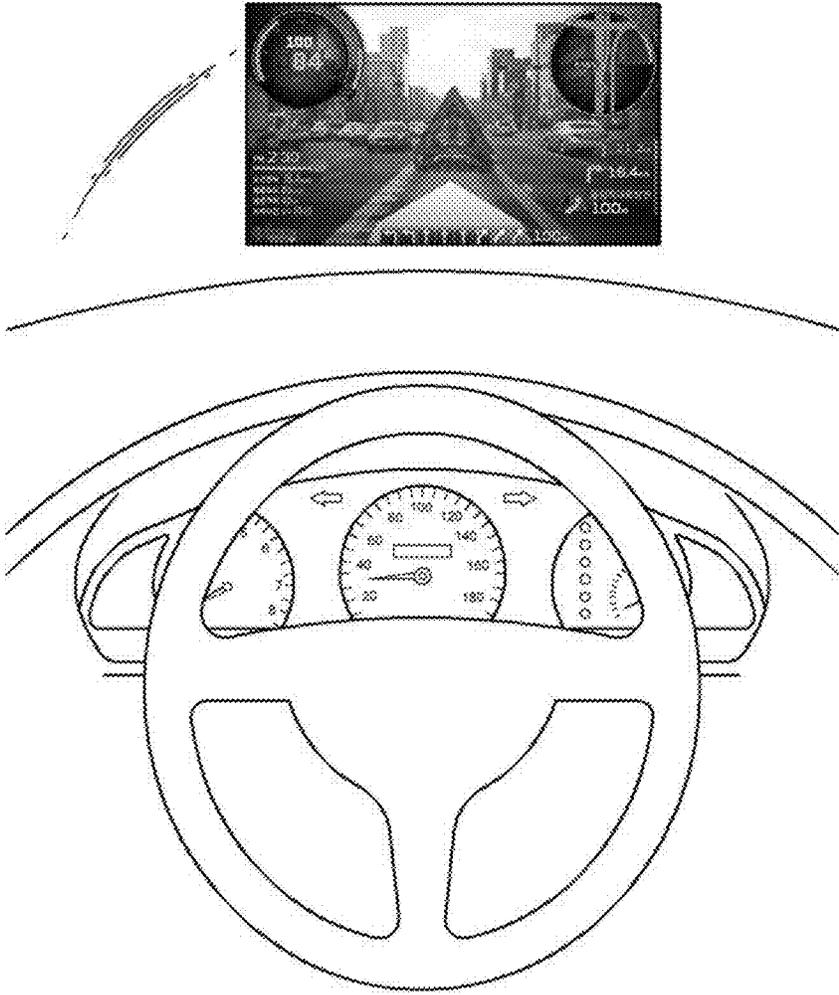


FIG. 21

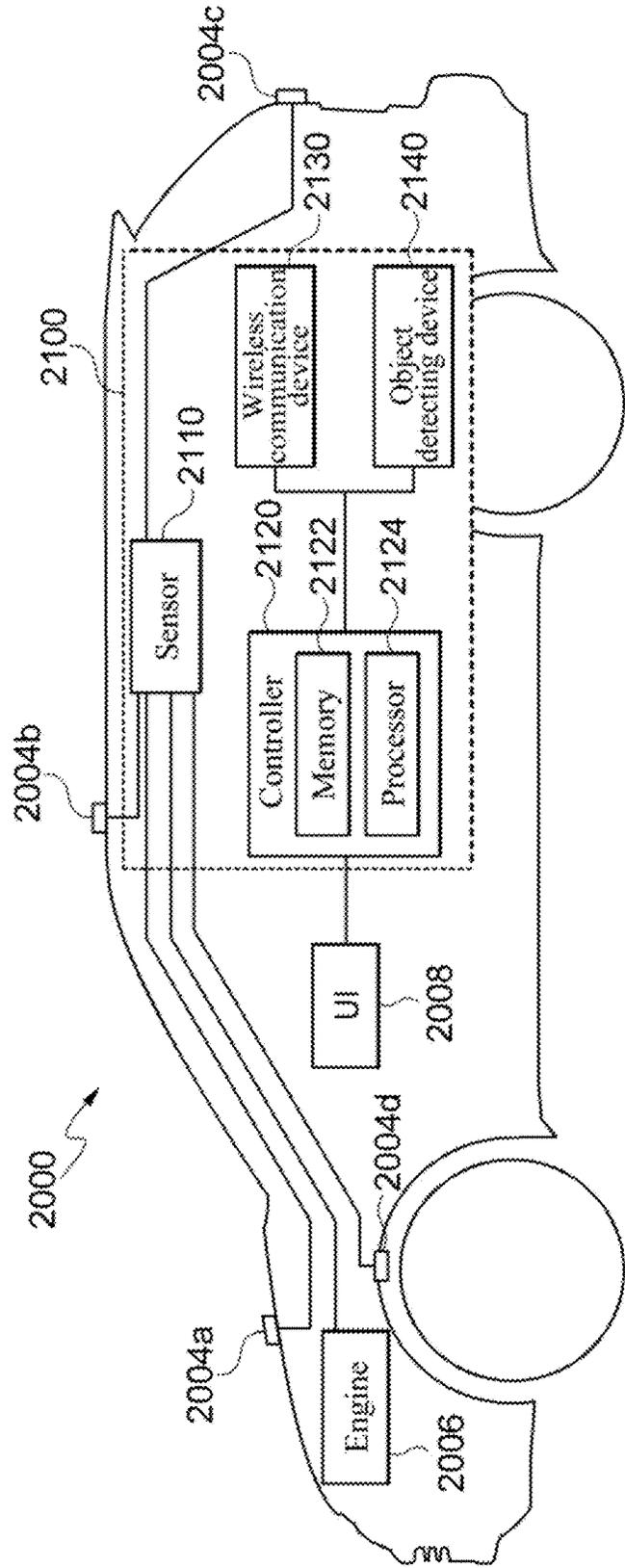
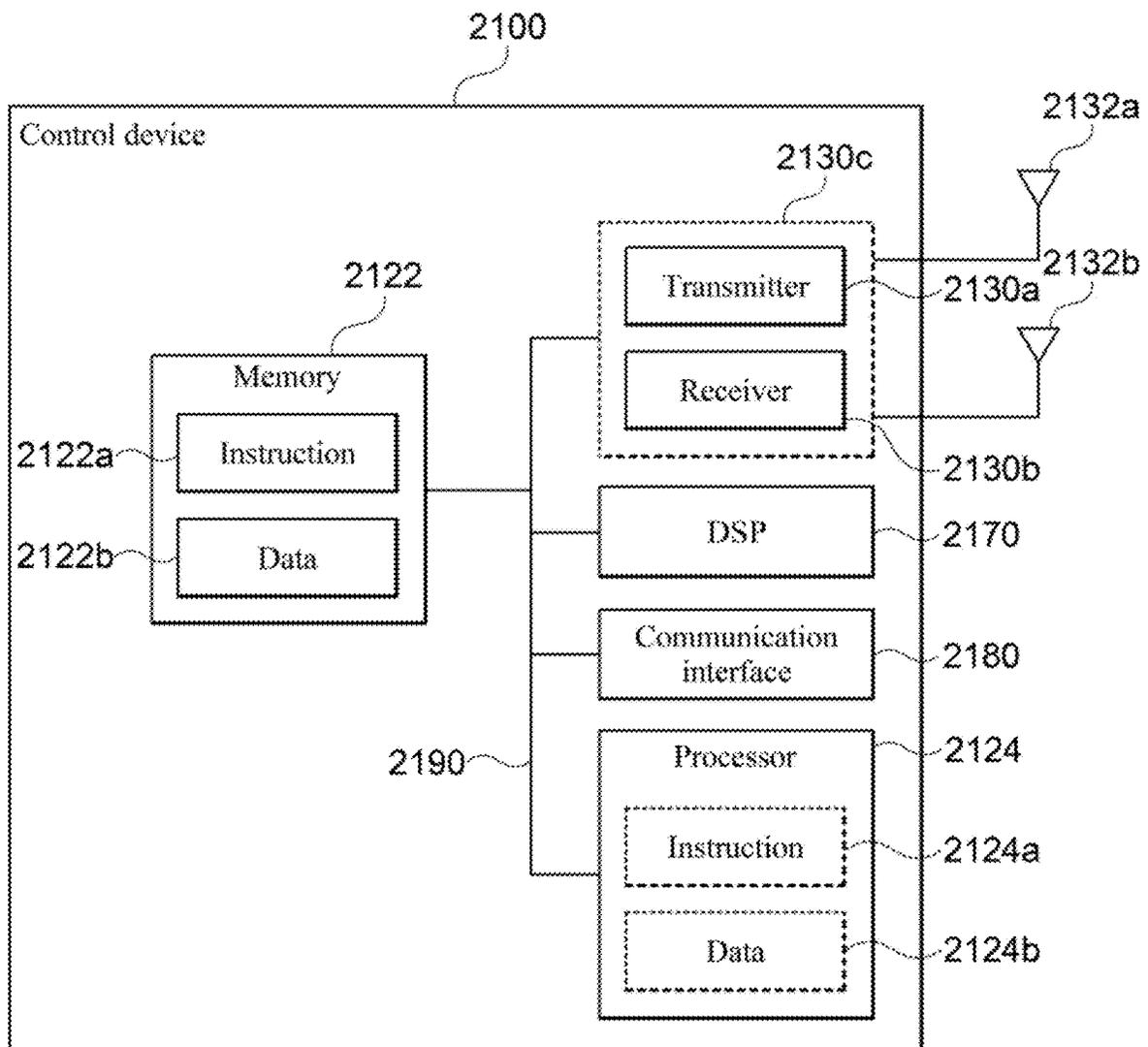


FIG. 22



**AR PROCESSING DEVICE, AUGMENTED
REALITY-BASED ROUTE GUIDANCE
METHOD AND ELECTRONIC DEVICE**

CROSS-REFERENCE TO RELATED
APPLICATION

This application claims the priority and benefit of Korean Patent Application No. 10-2020-0098828 filed on Aug. 6, 2020, Korean Patent Application No. 10-2020-0098847 filed on Aug. 6, 2020 and Korean Patent Application No. 10-2021-0100694 filed on Jul. 30, 2021 with the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a technology for displaying various AR objects related to a vehicle driving through AR.

2. Description of the Related Art

Augmented reality (AR) refers to a technology for synthesizing virtual objects or information in the real world to make them look like objects existing in a real environment.

Unlike virtual reality (VR) which synthesizes and displays virtual objects in the virtual world, AR synthesizes virtual objects in the real world, so additional information that is difficult to obtain only in the real world may be provided to users.

Because of these characteristics, AR has been applied to various fields.

An example is an AR navigation that performs vehicle driving-related guidance based on AR. Such AR navigation enhances user convenience by visually superimposing additional information on a screen that projects the real world users actually see. Examples of the additional information described above include a point of interest (POI), a graphic element indicating a route to a destination, and the like.

However, the AR navigation of a related art is disadvantageous in that it is vulnerable to displaying information at a distance from a vehicle and displaying information in a high-speed driving environment due to the limitations of a camera environment.

Due to these disadvantages, a shape and form of a route guidance object provided in the AR navigation of the related art cannot be expressed in an accurate composition, so that it is difficult for a driver to accurately understand a route through an object. In addition, in the AR navigation of the related art, various advanced driver assistance system (ADAS) objects, etc. are simply expressed as icons, which reduces the sense of reality, an advantage of AR, to lower driving convenience of drivers.

SUMMARY

An aspect of the present invention may provide a method of implementing a route guidance object displayed through augmented reality by combining a lane marking recognized during driving of a vehicle and link linear data of route data.

An aspect of the present invention may also provide a method of implementing a route guidance object displayed through AR that is intuitive, dynamic, and realistic to a driver.

An aspect of the present invention may also provide a method for expressing a lane departure warning system (LDWS) in a route guidance object when a lane departure occurs during driving of a vehicle.

According to an aspect of the present invention, an augmented reality (AR)-based route guidance method using a processor includes: acquiring a driving image captured by an image capturing device of a vehicle which is running; acquiring route data to a destination of the vehicle; recognizing both side lane markings of a lane in which the vehicle is running from the acquired driving image; generating first route guidance linear data based on the recognized both side lane markings for a region in which both side lane markings are recognized in the driving image; generating second route guidance linear data using link linear data of the route data for a region in which both side lane markings are not recognized in the driving image; combining the first route guidance linear data and the second route guidance linear data to generate combined route guidance linear data; and displaying a route guidance object in AR using the generated combined route guidance linear data.

The generating of the second route guidance linear data may include: calculating a translation value of points constituting the link linear data based on a position of a first point constituting the first route guidance linear data; and translating points constituting the link linear data based on the calculated translation value.

The generating of the second route guidance linear data may include: calculating a rotation angle of the link linear data based on a difference in angle between a driving direction vector of the vehicle and a route direction vector of the vehicle; and rotating the link linear data according to the translation based on the calculated rotation angle.

The AR-based route guidance method may further include: when only one side lane marking is recognized in the driving image, generating a virtual lane marking for the other side lane marking based on lane marking width data.

The route guidance object may include: a first route guidance object having a center in the combined route guidance linear data and having an arrow shape indicating a route along which the vehicle is to run; a second route guidance object indicated between a left side of the first route guidance object and a left lane marking; and a third route guidance object indicated between a right side of the first route guidance object and a right lane marking.

The route guidance object may be displayed to move from the front to the rear when the vehicle is running forwards, and a movement speed of the route guidance object may vary according to a speed of the vehicle.

The AR-based route guidance method may further include: when the vehicle approaches a turn point, displaying a turn point guidance object, without displaying the route guidance object.

The AR-based route guidance method may further include: when the vehicle leaves a lane marking, changing and displaying a display state of at least one of the second route guidance object and the third route guidance object.

According to an aspect of the present invention, an electronic device for performing augmented reality (AR)-based route guidance includes: a display unit configured to display a screen; a driving image acquiring unit configured to acquire a driving image captured by an image capturing device of a vehicle which is running; a route data acquiring unit configured to acquire route data to a destination of the vehicle; a lane marking recognizing unit configured to recognize both side lane markings of a lane in which the vehicle is running from the acquired driving image; a route

guidance linear data generating unit configured to generate first route guidance linear data based on the recognized both side lane markings for a region in which the both side lane markings are recognized in the driving image, generate second route guidance linear data using the link linear data of the route data for a region in which both side lane markings are not recognized in the driving image, and generate a combined route guidance linear data by coupling the first route guidance linear data and the second route guidance linear data; and a controller configured to control the display unit to display a route guidance object on an AR image using the generated combined route guidance linear data.

The route guidance object may include: a first route guidance object having a center in the combined route guidance linear data and having an arrow shape indicating a route along which the vehicle is to run; a second route guidance object indicated between a left side of the first route guidance object and a left lane marking; and a third route guidance object indicated between a right side of the first route guidance object and a right lane marking.

The route guidance object may be moved from the front to the rear and displayed in the AR image, and a movement speed of the route guidance object may vary according to a speed of the vehicle.

The controller may control the display unit to display a turn point guidance object, without displaying the route guidance object, when the vehicle approaches a turn point.

When the vehicle leaves a lane marking, the controller may control the display unit to change a display state of at least one of the second route guidance object and the third route guidance object and display the changed display state.

According to an aspect of the present invention, an augmented reality (AR) processing device includes: a driving image acquiring unit configured to acquire a driving image captured by an image capturing device of a vehicle which is running; a route data acquiring unit configured to acquire route data to a destination of the vehicle; a lane marking recognizing unit configured to recognize both side lane markings of a lane in which the vehicle is running from the acquired driving image; a route guidance linear data generating unit configured to generate first route guidance linear data based on the recognized both side lane markings for a region in which both side lane markings are recognized in the driving image, generate second route guidance linear data using link linear data of the route data for a region in which both side lane markings are not recognized in the driving image, and combine the first route guidance linear data and the second route guidance linear data to generate combined route guidance linear data; and an AR image generating unit configured to generate an AR image in which a route guidance object is mapped based on the generated combined route guidance linear data.

The route guidance linear data generating unit may calculate a translation value of points constituting the link linear data based on a position of a first point constituting the first route guidance linear data and translate points constituting the link linear data based on the calculated translation value.

The route guidance linear data generating unit may calculate a rotation angle of the link linear data based on a difference in angle between a driving direction vector of the vehicle and a route direction vector of the vehicle and rotate the link linear data according to the translation based on the calculated rotation angle.

When only one side lane marking is recognized in the driving image, the route guidance linear data generating unit

may generate a virtual lane marking for the other side lane marking based on lane marking width data.

According to an aspect of the present invention, a program stored in a computer-readable recording medium including a program code for performing the augmented reality (AR)-based route guidance method described above may be provided.

According to an aspect of the present invention, a computer-readable recording medium storing a program for performing the augmented reality (AR)-based route guidance method described above may be provided.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a block diagram illustrating an AR (AR) processing device according to an exemplary embodiment of the present invention.

FIG. 2 is a block diagram specifically illustrating an AR image generating unit according to an exemplary embodiment of the present invention.

FIG. 3 is a view illustrating a driving environment of a vehicle according to an exemplary embodiment of the present invention.

FIG. 4 is a view illustrating a method of generating a route guidance linear data according to an exemplary embodiment of the present invention.

FIG. 5 is a view illustrating correction of an error of second route guidance linear data when a vehicle changes lanes according to an exemplary embodiment of the present invention.

FIG. 6 is a view illustrating correction of an error of second route guidance linear data when a vehicle is driving in a curve section according to an exemplary embodiment of the present invention.

FIGS. 7A and 7B are views illustrating a conversion relation between a captured image and a virtual 3D space according to an exemplary embodiment of the present invention.

FIG. 8 is a view illustrating a route guidance object according to an exemplary embodiment of the present invention.

FIG. 9 is a view illustrating an AR processing device according to another exemplary embodiment of the present invention.

FIG. 10 is a block diagram of an electronic device according to an exemplary embodiment of the present invention.

FIG. 11 is a view illustrating a system network connected to an electronic device according to an exemplary embodiment of the present invention.

FIG. 12 is a flowchart illustrating a method of generating an AR image according to an exemplary embodiment of the present invention.

FIG. 13 is a flowchart specifically illustrating a step of generating linear data according to an exemplary embodiment of the present invention.

FIG. 14 is a view illustrating an AR image displayed through an electronic device when route guidance to a destination is performed.

FIG. 15 is a view illustrating an AR image displayed through an electronic device when a vehicle deviates from a lane marking.

FIGS. 16 to 17 are views illustrating AR images displayed through an electronic device when a vehicle approaches a turn point.

FIG. 18 is a view illustrating an implementation form when an electronic device does not include an image capturing unit according to an exemplary embodiment of the present invention.

FIG. 19 is a view illustrating an implementation form when an electronic device includes an image capturing unit according to an exemplary embodiment of the present invention.

FIG. 20 is a view illustrating an implementation form using a head-up display (HUD) according to an exemplary embodiment of the present invention.

FIG. 21 is a block diagram illustrating an autonomous driving system according to an exemplary embodiment of the present invention.

FIG. 22 is a block diagram illustrating a configuration of an autonomous vehicle according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION

The following description illustrates only a principle of the present invention. Therefore, those skilled in the art may implement the principle of the present invention and devise various apparatuses included in the spirit and scope of the present invention although not clearly described or shown in the present specification. In addition, it is to be understood that all conditional terms and exemplary embodiments mentioned in the present specification are obviously intended only to allow those skilled in the art to understand a concept of the present invention in principle, and the present invention is not limited to exemplary embodiments and states particularly mentioned as such.

Further, it is to be understood that all detailed descriptions mentioning specific exemplary embodiments of the present invention as well as principles, aspects, and exemplary embodiments of the present invention are intended to include structural and functional equivalences thereof. Further, it is to be understood that these equivalences include an equivalence that will be developed in the future as well as an equivalence that is currently well-known, that is, all devices devised so as to perform the same function regardless of a structure.

Therefore, it is to be understood that, for example, a block diagram of the present specification shows a conceptual aspect of an illustrative circuit for embodying a principle of the present invention. Similarly, it is to be understood that all flowcharts, state transition views, pseudo-codes, and the like show various processes that may be tangibly embodied in a computer-readable medium and that are executed by computers or processors regardless of whether or the computers or the processors are clearly illustrated.

Functions of various devices including processors or functional blocks represented as concepts similar to the processors and illustrated in the accompanying drawings may be provided by hardware having the capability to execute appropriate software as well as dedicated hardware. When the functions are provided by the processors, the above-mentioned functions may be provided by a single dedicated processor, a single shared processor, or a plurality of individual processors, in which some of them may be shared.

In addition, terms mentioned as a processor, a control, or a concept similar to the processor or the control should not be interpreted to exclusively cite hardware having capability to execute software, but should be interpreted to implicitly include digital signal processor (DSP) hardware and a read only memory (ROM), a random access memory (RAM), and

a non-volatile memory for storing software without being limited thereto. The above-mentioned terms may also include well-known other hardware.

In the claims of the present specification, components represented as means for performing functions mentioned in a detailed description are intended to include all methods for performing functions including all types of software including, for example, a combination of circuit devices performing these functions, firmware/micro codes, or the like, and are coupled to appropriate circuits for executing the software. It is to be understood that since functions provided by variously mentioned means are combined with each other and are combined with a scheme demanded by the claims in the inventions defined by the claims, any means capable of providing these functions are equivalent to means recognized from the present specification.

The above-mentioned objects, features, and advantages will become obvious from the following detailed description provided in relation to the accompanying drawings. Therefore, those skilled in the art to which the present invention pertains may easily practice a technical idea of the present invention. Further, in describing the present invention, in the case in which it is judged that a detailed description of a well-known technology associated with the present invention may unnecessarily make unclear the gist of the present invention, it will be omitted.

Hereinafter, various exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings.

FIG. 1 is a block diagram illustrating an AR processing device according to an exemplary embodiment of the present invention. FIG. 2 is a block diagram specifically illustrating an AR image generating unit according to an exemplary embodiment of the present invention. Referring to FIGS. 1 and 2, the AR processing device 10 may include an image acquiring unit 11, a route data acquiring unit 12, a lane marking recognizing unit 13, a route guidance linear data generating unit 14, and an AR image generating unit 15.

Here, the AR image generating unit 15 may include all or some of a calibration unit 15-1, a virtual 3D space generating unit 15-2, an object generating unit 15-3, and a mapping unit 15-4.

The AR processing device 10 may generate an AR image for guiding a vehicle user based on a driving image captured by an image capturing device of a vehicle.

Here, driving of the vehicle refers to a state in which the vehicle is driven by a driver and located on the road, and may have a concept of including all of a driving state in which the vehicle is running on the road, a stopped state in which the vehicle is standing on the road, and a parking state of the vehicle.

In addition, the vehicle user may be a concept including both a vehicle driver and a vehicle non-driver (e.g., a fellow passenger, a passenger, etc.)

In addition, the drive image captured by the imaging device of the vehicle may include a front drive image according to imaging of a front of the vehicle and a rear drive image according to imaging of a rear of the vehicle.

The AR processing device 10 may be implemented using software, hardware, or a combination thereof. For example, according to hardware implementation, the lane marking detecting apparatus 10 may be implemented using at least one of application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, control-

lers, micro-controllers, micro-processors, and electric units for performing other functions.

Hereinafter, for convenience of description, each component module of the AR processing device **10** will be described in detail based on a case in which the drive image is a front drive image as an example.

The image acquiring unit **11** may acquire a drive image captured by the imaging device of the vehicle. Specifically, the image acquiring unit **11** may acquire, in real time, a drive image captured by the imaging device installed in the vehicle while the vehicle is running.

Here, the acquired drive image may include a plurality of lanes demarcated along a lane marking, a road including a plurality of lanes, and a plurality of vehicles running on the road.

A lane marking may refer to each of both side lines forming a lane in which a vehicle is located. In addition, a lane may refer to a road formed by lane markings such as a primary lane, a secondary lane, or an N lane, in which a vehicle is running.

The route data acquiring unit **12** may acquire route data to the destination of the vehicle from the map data. Here, the map data may be obtained from the storage unit **110** of the electronic device **100** in which the AR processing device **10** is installed, may be obtained through wired/wireless communication between the electronic device **100** and a separate external map database, or may be obtained from another electronic device.

The route data may include link data and node data for indicating a route to the destination of the vehicle.

Here, the link data may include link linear data and link attribute data.

That is, in the map data, a road or each lane constituting the road may be configured by a connection of a plurality of links, the link linear data may be data representing linear characteristics of a link, and a position data for at least one point constituting a line may be allocated to the link linear data. Here, the position data may be GPS data. Such link linear data may be used to generate route guidance linear data for display of a route guidance object in AR.

Also, the link attribute data may include at least one of an identifier of a link, data indicating whether the link is a bidirectional link or a unidirectional link, starting and ending points of a link based on a vehicle traveling direction, a road number, a road name, a road length, road rank information, road type information, road width data, road land number data and road slope data, and guidance code data (e.g., data for guiding speed limits, control points, etc.).

The node data may include an identifier of a node, attribute data for the node, and position data for the node. Here, the position data may be GPS data, and the node attribute data may include a direction attribute of the node.

The lane marking recognizing unit **13** may recognize a lane marking of a lane in which the vehicle is running from the driving image obtained by the image acquiring unit **11**. Specifically, the lane marking recognizing unit **13** may detect an edge corresponding to the lane marking in the driving image acquired by the image acquiring unit **11** and generate an edge image based on the detected edge. In addition, the lane marking recognizing unit **13** may detect a straight line component based on the detected edge and generate an edge straight line processed image based on the detected straight line component. In addition, the lane marking recognizing unit **13** may detect a lane marking point corresponding to the lane marking using the generated edge image and the edge straight line processed image. In addition,

tion, the lane marking recognizing unit **13** may recognize a lane marking based on the detected lane marking point.

In this case, the lane marking recognizing unit **13** may recognize both sides lane markings in which the vehicle is running by detecting a lane marking point corresponding to a left lane marking and a lane marking point corresponding to right lane marking, respectively.

The route guidance linear data generating unit **14** may generate route guidance linear data used to display a route guidance object in AR. Specifically, the route guidance linear data generating unit **14** may generate first route guidance linear data based on the recognized both lane markings for a region in which the both lane markings are recognized in the driving image, and generate second route guidance linear data using link linear data of the route data for a region in which both sides lane markings are not recognized in the driving image. In addition, the route guidance linear data generating unit **14** may combine the generated first route guidance linear data and the second route guidance linear data to generate combined route guidance linear data.

The operation of the route guidance linear data generating unit **14** will be described in more detail with reference to FIGS. **3** to **4**.

FIG. **3** is a view illustrating a driving environment of a vehicle according to an exemplary embodiment of the present invention. FIG. **4** is a view illustrating a method of generating a route guidance line according to an exemplary embodiment of the present invention.

There may be a case **31** in which the vehicle travels in a lane region **31-2** in which part of a lane marking is erased while driving or a case **32** in which the vehicle travels in a lane region **32-2** in which part of a lane marking is blocked by a preceding vehicle. In this case, the lane marking recognizing unit **13** may recognize the lane marking in part of lane regions **31-1** and **32-1** located in front of the vehicle, but may not recognize a lane marking in the remaining part of lane regions **31-2** and **32-2**.

Alternatively, there may be a case **33** in which a lane marking is not recognized by the lane marking recognizing unit **13** because the lane marking is blurred or located at a distance. Also, in this case, the lane marking recognizing unit **13** may recognize a lane marking in part of a lane region **33-1** located in front of the vehicle but may not recognize a lane marking in the remaining part of lane region **33-2**.

Accordingly, with respect to a region **41-1** in which both side lane markings are recognized in the driving image, first route guidance linear data may be generated based on the recognized both side lane markings. Specifically, the route guidance linear data generating unit **14** may determine a virtual point **41-4** located in the middle based on a plurality of points **41-2** constituting a left lane marking detected by the lane marking recognizing unit **13** and a plurality of points **41-3** constituting a right lane marking and connect the virtual points to generate first route guidance linear data **41-5**.

However, in the driving image, with respect to the region **42-1** in which both lane markings are not recognized, second route guidance linear data may be generated using the link linear data of the route data. Specifically, the route guidance linear data generating unit **14** may detect link linear data **43-1** and **43-2** corresponding to the region **41-1** in which the both side lane markings are not recognized based on a current position of the vehicle, among a plurality of link linear data **43**, and generate the second route guidance linear data **42-5** based on the detected link linear data **43-1** and **43-2**.

Meanwhile, the route guidance linear data generating unit **14** may combine the generated first route guidance linear data **41-5** and the second route guidance linear data **42-5** to generate combined route guidance linear data **44**.

Meanwhile, when generating the combined route guidance linear data **44**, the route guidance linear data generating unit **14** may perform error correction of the second route guidance linear data **42-5**.

Specifically, the route guidance linear data generating unit **14** may calculate translation values of points constituting the link linear data based on a position of a first point constituting the first route guidance linear data. In addition, the route guidance linear data generating unit **14** may translate the points constituting the link linear data based on the calculated translation value.

Also, the route guidance linear data generating unit **14** may calculate a rotation angle of the link linear data based on an angle difference between a driving direction vector of the vehicle and a route direction vector of the vehicle. In addition, the route guidance linear data generating unit **14** may rotate the link linear data according to the translation based on the calculated rotation angle.

The error correction of the route guidance linear data generating unit **14** will be described in more detail with reference to FIGS. **5** to **6**.

FIG. **5** is a view illustrating error correction of second route guidance linear data when changing lanes of a vehicle according to an exemplary embodiment of the present invention.

Reference numeral **71** denotes a process of changing a lane from a second lane to a first lane while the vehicle is running, and an image captured in a vehicle **71-1** driving in the second lane may correspond to reference numeral **72**, and an image captured in a vehicle **71-2** changing to the first lane may correspond to reference numeral **73**.

In this case, the route guidance linear data generating unit **14** may generate first route guidance linear data based on the recognized both side lanes for regions **72-1** and **73-1** in which both side lanes are recognized in the driving image.

However, in the driving image, for regions **72-3** and **73-3** in which both side lanes are not recognized, the route guidance linear data generating unit **14** may generate second route guidance linear data using link linear data **75** and **76** of the route data.

In this case, a position error may exist between the position data of the vehicle and the position data allocated to the link linear data. Accordingly, the route guidance linear data generating unit **14** according to an exemplary embodiment of the present invention may determine a position of first points **72-2** and **73-2** constituting the first route guidance linear data based on the position data of the vehicles **71-1** and **71-2** in motion and determine initial positions **75-1** and **76-1** of the points constituting the link linear data based on the position data of the link linear data **75** and **76**. Here, the first points **72-2** and **73-2** may be the last points of the first route guidance linear data of the recognition regions **72-1** and **73-1**.

Meanwhile, the route guidance linear data generating unit **14** may calculate a translation value dl of the initial positions **75-1** and **76-1** of the points constituting the link linear data based on the positions of the first points **72-2** and **73-2** constituting the first route guidance linear data. Also, the route guidance linear data generating unit **14** may generate second route guidance linear data **75-2** and **76-2** obtained by translating the points constituting the link linear data based on the calculated translation value dl .

Meanwhile, when an optical axis vector V_1 of the vehicle and a route direction vector V_2 of the vehicle are different from each other as in the vehicle **71-2** changing to the first lane, an angular error may exist. Here, the optical axis vector V_1 of the camera installed in the vehicle has the same meaning as a driving direction vector facing a driving direction of the vehicle and may be used as the same concept.

Accordingly, the route guidance linear data generating unit **14** may calculate a rotation angle of the link linear data based on an angular difference θ between the optical axis vector V_1 of the vehicle and the route direction vector V_2 of the vehicle. As an example, the rotation angle may include a rotation direction and a magnitude of a rotation angle of the route direction vector V_2 of the vehicle based on the optical axis vector V_1 of the vehicle.

Also, the route guidance linear data generating unit **14** may rotate the link linear data according to the translation at the same rotational angle in the same rotational direction based on the calculated rotation angle.

Accordingly, the route guidance linear data generating unit **14** may generate second route guidance linear data **76-3** obtained by correcting a position error and an angle error.

FIG. **6** is a view illustrating error correction of the second route guidance linear data when a vehicle is running on a curve according to an exemplary embodiment of the present invention.

Reference numeral **81** denotes that the vehicle travels in a curve section, and an image captured in a vehicle **81-1** before entering the curve section may correspond to reference numeral **82**, and an image captured in a vehicle **81-2** driving in the curve section may correspond to reference numeral **83**.

In this case, for regions **82-1** and **83-1** in which both side lanes are recognized in the driving images, the route guidance linear data generating unit **14** may generate first route guidance linear data based on the recognized both side lanes.

However, for regions **82-3** and **83-3** in which both side lanes are not recognized in the driving images, the route guidance linear data generating unit **14** may generate second route guidance linear data using link linear data **85** and **86** of the route data.

In this case, a position error may exist between the position data of the vehicle and the position data allocated to the link linear data. Thus, the route guidance linear data generating unit **14** according to an exemplary embodiment of the present invention may determine positions of first points **82-2** and **83-2** constituting the first route guidance linear data and determine initial positions **85-1** and **86-1** of the points constituting the link linear data based on the position data of the link linear data **85** and **86**. Here, the first points **82-2** and **83-2** may be the last points of the first route guidance linear data of the recognition regions **82-1** and **83-1**.

Meanwhile, the route guidance linear data generating unit **14** may calculate a translation value dl of the initial positions **85-1** and **86-1** of the points constituting the link linear data based on the positions of the first points **82-2** and **83-2** constituting the first route guidance linear data. Also, the route guidance linear data generating unit **14** may generate second route guidance data **85-2** and **86-2** obtained by translating the points constituting the link linear data based on the calculated translation value dl .

Meanwhile, when the vehicle runs in a curve section, since the optical axis vector V_1 of the vehicle and the route direction vector V_2 of the vehicle are different from each other, and thus, an angular error may exist. Accordingly, the

route guidance linear data generating unit **14** may calculate a rotation angle of the link linear data based on angular differences θ_1 and θ_2 between the vehicle optical axis vector V_1 and the vehicle route direction vector V_2 .

As an example, the rotation angle may include a rotation direction and a magnitude of the rotation angle of the route direction vector V_2 of the vehicle based on the optical axis vector V_1 of the vehicle.

Also, the route guidance linear data generating unit **14** may rotate the link linear data according to translation based on the calculated rotation angle in the same rotation direction at the same rotation angle. Accordingly, the route guidance linear data generating unit **14** may generate second route guidance linear data **86-3** in which the position error and the angle error are corrected.

However, since there is no angle difference between the optical axis vector V_1 of the camera and the route direction vector V_2 of the vehicle before entering the curve section, rotation correction may be unnecessary.

Meanwhile, when only one lane marking is recognized in the driving image, the route guidance linear data generating unit **14** may generate a virtual lane marking for the other side lane marking based on the lane width data. Also, the route guidance linear data generating unit **14** may determine a virtual point located in the middle based on the one side lane marking recognized by the lane marking recognizing unit **13** and a virtual lane marking of the other side generated virtually, and connect virtual points to generate route guidance linear data. In addition, the route guidance linear data generating unit **14** may combine the route guidance linear data generated through the virtual point with route guidance linear data of a region in which both lane markings are not recognized, to generate combined route guidance linear data.

Meanwhile, the AR image generating unit **15** may generate an AR image for displaying various objects on the AR using the combined route guidance linear data generated by the route guidance linear data generating unit **14**. The AR image generating unit **15** will be described in more detail with reference to FIG. 2.

The calibration unit **15-1** may perform calibration for estimating a camera parameter corresponding to a camera from a captured image captured by the camera. Here, the camera parameter may be a parameter constituting a camera matrix, which is information indicating a relationship between an actual space (or the real world) and a photograph.

Here, as shown in FIG. 7A, the parameter may include extrinsic parameters **601** and intrinsic parameters **602**. Here, f_x and f_y of the intrinsic parameters **602** may be focal lengths, c_x and c_y may be principal points, and $\text{skew}_c = \tan \alpha$ may be skew coefficients. In addition, the extrinsic parameters **601** may be rotation/translation conversion matrix for converting the coordinates X , Y , and Z of a 3D point on a world coordinate system **605** into coordinates X_c , Y_c , and Z_c of the 3D point on a camera coordinate system **604**. Since these extrinsic parameters of the camera are not parameters unique to the camera, the extrinsic parameters may vary depending on where and in what direction the camera is installed, and may also vary depending on how the world coordinate system is defined.

That is, the calibration unit **15-1** according to the present invention may perform calibration for estimating a camera parameter corresponding to a camera from a captured image.

The virtual 3D space generating unit **15-2** may generate a virtual 3D space based on the captured image captured by the camera. Specifically, the virtual 3D space generating unit **15-2** may acquire depth information from the image cap-

ured by the camera based on the camera parameter estimated by the calibration unit **15-1**, and generate a virtual 3D space based on the acquired depth information and the captured image. Specifically, referring to FIG. 7B, the camera-captured image is obtained by perspective-projecting points on a three-dimensional (3D) space of the world coordinate system **605** onto a two-dimensional (2D) image plane of the image coordinate system **603**. Accordingly, the 3D space generating unit **15-2** may generate a virtual 3D space of the world coordinate system **605** for the captured image of the camera by performing a reverse process of the operation described above based on the camera parameters.

That is, the virtual 3D space generating unit **15-2** according to the present invention obtains depth information from the driving image based on the camera parameter estimated by the calibration unit **15-1** and generates a virtual 3D space based on the depth information and the driving image.

The object generating unit **15-3** may generate various objects for guidance on the AR. In the present invention, an object will be described as referring to various graphic elements displayed through AR. Here, the object may include various graphic elements for guidance, while the vehicle is driving, such as a front vehicle collision avoidance guidance object, a route guidance object, a lane departure guidance object, a curve guidance object, and a turn point guidance object.

For example, when a request for route guidance to a destination is input by a user, the object generating unit **15-3** may generate a route guidance object for displaying a route from a current position of the vehicle to the destination on a captured image corresponding to the real world. Such a route guidance object will be described in detail with reference to FIG. 8.

Referring to FIG. 8, a route guidance object generated by the object generating unit **15-3** may include a first route guidance object **611** in an arrow shape and second and third route guidance objects **612** and **613** in a rectangular shape. Here, the first route guidance object **611** has an arrow shape pointing to a route on which the vehicle should travel, and may be arranged based on the combined route guidance linear data generated by the route guidance linear data generating unit **14** and displayed through AR. In addition, the second route guidance object **612** may be disposed between the left of the first route guidance object **611** and a left lane marking and displayed through AR, and the third route guidance object **613** may be disposed between the right of the first route guidance object **611** and a right lane marking and displayed through AR.

Here, the colors of the route guidance objects **611**, **612**, and **613** may vary according to the driving environment of the vehicle. In addition, the second route guidance object **612** and the third route guidance object **613** may be implemented such that transparency thereof increases from the outside to the inside.

Meanwhile, the object generating unit **15-3** may generate a lane departure guidance object for guiding lane departure in a captured image corresponding to the real world when the vehicle deviates from a lane marking of a lane in which the vehicle is running.

Also, when the vehicle approaches the turn point while the vehicle is running, the object generating unit **15-3** may generate a turn point guidance object for guiding a turn point in a captured image corresponding to the real world.

Also, when the vehicle approaches a front vehicle while driving, the object generating unit **15-3** may generate a front vehicle collision avoidance guidance object in a captured image corresponding to the real world.

Here, the object may be implemented as a 3D object, a texture image, or an art line.

The mapping unit 15-4 may determine a mapping position of an object generated by the object generating unit 15-3 in the virtual 3D space generated by the virtual 3D space generating unit 15-2, and map the object to the determined mapping position. That is, the mapping unit 16-4 according to the present invention may determine the mapping position in the virtual 3D space according to a type of the guidance object generated by the object generating unit 15-3 and generate virtual 3D spatial data mapped to the determined mapping position.

The AR image generating unit 15 may generate an AR image by converting the virtual 3D spatial data to which the object is mapped into a 2D image using a camera matrix.

When a route guidance object is generated by the object generating unit 15-3, the mapping unit 15-4 may calculate a position of a combined route guidance linear data generated by the route guidance linear data generating unit 14 in the virtual 3D space, a position of a left lane marking in the virtual 3D space, and a position of a right lane marking in the virtual 3D space. Also, the mapping unit 15-4 may determine a mapping position of the route guidance object based on the positions calculated in the virtual 3D space, and generate virtual 3D space data mapped to the determined mapping position.

In this case, the mapping unit 15-4 may determine the mapping position of the route guidance object so that the center of the first route guidance object 611 is located at the position of the combined route guidance linear data in the virtual 3D space. In addition, the mapping unit 15-4 may determine the mapping position of the second route guidance object 612 between the position of the left lane marking in the virtual 3D space and the position of the first route guidance object 611 in the virtual 3D space. In addition, the mapping unit 15-4 may determine the mapping position of the third route guidance object 613 between the position of the right lane marking in the virtual 3D space and the position of the first route guidance object 611 in the virtual 3D space. Also, the mapping unit 15-4 may generate virtual 3D spatial data mapped to the determined mapping positions of the first route guidance object 611, the second route guidance object 612, and the third route guidance object 613, respectively. In addition, the AR image generating unit 15 may generate an AR image by converting the virtual 3D spatial data to which the route guidance objects 611, 612, and 613 are mapped into a 2D image using a camera matrix. Accordingly, the image captured by the camera and the route guidance objects 611, 612, and 613 may be overlapped and displayed on the AR image.

Here, the first route guidance object 611 may be displayed by moving from front to rear when the vehicle is driving forward. That is, the first route guidance object 611 displayed in front of the vehicle may be displayed closer to the vehicle when the vehicle is running forward.

Also, a moving speed of the first route guidance object 611 may vary according to a driving speed of the vehicle. That is, when a forward driving speed of the vehicle increases, the speed at which the first route guidance object 611 moves from front to rear may also increase. Also, when the forward driving speed of the vehicle decreases, the speed at which the first route guidance object 611 moves from front to rear may also decrease. Also, when the vehicle's forward driving speed is "0" in a stopped state, the moving speed of the first route guidance object 611 may also be "0" and may not move.

When at least one of a turn point guidance object, a front vehicle collision avoidance guidance object, and a lane departure avoidance guidance object is generated in the object generating unit 15-3, the mapping unit 15-4 may calculate positions of the generated objects in virtual 3D space. In addition, the mapping unit 15-4 may determine mapping positions of the objects based on the positions calculated in the virtual 3D space, and generate virtual 3D space data mapped to the determined mapping positions. In addition, the AR image generating unit 15 may generate an AR image by converting the virtual 3D spatial data to which an object is mapped into a 2D image using a camera matrix. Accordingly, at least one of the camera-captured image, the turn point guidance object, the front vehicle collision avoidance guidance object, and the lane departure avoidance guidance object may be displayed on the AR image.

Meanwhile, when the vehicle leaves the lane marking, the AR image generating unit 15 may generate an AR image displayed by changing a display state of at least one of the second route guidance object 612 and the third route guidance object 613. For example, the AR image generating unit 15 may generate an AR image in which colors of the second route guidance object 612 and the third route guidance object 613 before the vehicle leaves the lane marking and colors of the second route guidance object 612 and the third route guidance object 613 after the vehicle leaves the lane marking are displayed to be different. As another example, the AR image generating unit 15 may generate an AR image in which a route guidance object corresponding to a lane marking side from which the vehicle deviates, among the second route guidance object 612 and the third route guidance object 613 (e.g., the second route guidance object 612 when the vehicle deviates from the left lane marking and the third route guidance object 613 when the vehicle deviates from the right lane marking), is displayed discriminately.

In addition, when the vehicle approaches a turn point, the AR image generating unit 15 may generate an AR image in which a turn point guidance object is displayed, without displaying the first route guidance object 611, the second route guidance object 612, and the third route guidance object 613.

FIG. 9 is a block diagram illustrating an AR processing device according to another exemplary embodiment of the present invention. Referring to FIG. 9, the AR processing device 20 according to another exemplary embodiment of the present invention may further include a curving unit 16 and a filtering unit 17 in the AR processing device 10 according to FIG. 1.

The curving unit 16 may curve both side lane markings recognized by the lane marking recognizing unit 13.

Specifically, the curving unit 16 may detect a plurality of lane marking points from each of the recognized lane markings on both sides, project the detected lane marking points on a virtual 3D space through camera projection, and calculate a curved spatial linear line corresponding to the lane marking points in the virtual 3D space, thereby curving both side lane markings.

Also, the curving unit 16 may analyze even the first route guidance linear data and the second route guidance linear data generated by the route guidance linear data generating unit 14 and perform curving thereon in a virtual 3D space as described above.

Here, the curving unit 16 may perform curving on a Bezier curve, for example.

Through the curving process of the curving unit 16, an irregular lane marking recognition result may be calculated as a smooth lane marking.

Meanwhile, the filtering unit **17** may perform a filtering process on the spatial coordinates calculated in the operation process of the device.

Specifically, the filtering unit **17** may perform filtering to remove noise points from spatial coordinates in a virtual 3D space corresponding to a plurality of lane marking points of both side lane markings recognized by the lane marking recognizing unit **13**.

In addition, the filtering unit **17** may analyze even the first and second route guidance linear data generated by the route guidance linear data generating unit **14** in a virtual 3D space and perform filtering as described above.

Here, the filtering unit **17** may perform filtering processing using, for example, a mean filter. By using such an average filter, it is possible to control the route guidance object to smoothly move by weighted-averaging the currently obtained spatial coordinates and past spatial coordinates when the vehicle changes a lane.

FIG. **10** is a block diagram illustrating an electronic device according to an exemplary embodiment of the present invention. Referring to FIG. **10**, the electronic device **100** includes all or some of a storage unit **110**, an input unit **120**, an output unit **130**, an AR processing unit **160**, a controller **170**, and a communication unit **180**, a sensing unit **190**, and a power supply unit **195**.

Here, the electronic device **100** may be implemented as various devices such as a smartphone, a tablet computer, a notebook computer, a personal digital assistant (PDA), a portable multimedia player (PMP), a smart glass, a project glass, a navigation device, or a car dash cam or a car video recorder, which is an imaging device for a vehicle, and may be provided in a vehicle.

Driving-related guidance may include various guidance for assisting a driver in driving a vehicle such as route guidance, lane departure guidance, lane maintenance guidance, front vehicle departure guidance, traffic light change guidance, front vehicle collision prevention guidance, lane change guidance, lane guidance, curve guidance, etc.

Here, the route guidance may include an AR route guidance for performing route guidance by combining various information such as a user's position and direction to an image obtained by capturing a front of a running vehicle or 2-dimensional (2D) or a 3-dimensional (3D) route guidance for performing route guidance by combining various information such as a user's position and direction to 2D or 3D map data.

In addition, the route guidance may include aerial map route guidance for performing route guidance by combining various information such as a user's position and direction with the aerial map data. Here, the route guidance may be interpreted as a concept including not only a case in which a user rides in a vehicle and drives but also a case in which a user walks or jumps to move.

In addition, the lane departure guidance may guide whether a vehicle which is running has deviated from a lane marking.

In addition, the lane maintenance guidance may guide the vehicle to return to an original driving lane.

In addition, the front vehicle departure guidance may guide whether a vehicle located in front of a vehicle being stopped is departing.

In addition, the traffic light change guidance may guide whether a signal change of a traffic light located in front of the vehicle being stopped. For example, when a red traffic light indicating a stop signal is turned on and is changed to a blue traffic light indicating a start signal, this may be guided.

In addition, the front vehicle collision prevention guidance may guide to prevent a collision with the vehicle in front when a distance between a vehicle stopped or running and a vehicle located in front of the vehicle is within a predetermined distance.

In addition, the lane change guidance may guide a change from a lane in which a vehicle is located to another lane in order to guide a route to a destination.

In addition, the lane guidance may guide the lane in which the vehicle is currently located.

In addition, the curve guidance may guide that a road on which the vehicle will travel after a predetermined time is a curve.

The driving-related images, such as a front image of a vehicle that enables the provision of various guidance, may be captured by a camera mounted on the vehicle or a camera of a smart phone. Here, the camera may be a camera integrally formed with the electronic device **100** mounted on the vehicle to image the front of the vehicle.

As another example, the camera may be a camera mounted on a vehicle separately from the electronic device **100** to image the front of the vehicle. In this case, the camera may be a separate imaging device for a vehicle mounted toward the front of the vehicle and the electronic device **100** may receive a captured image through wired/wireless communication from the separately mounted imaging device for a vehicle, or when a storage medium storing the captured image of the imaging device for a vehicle is inserted into the electronic device **100**, the electronic device **100** may receive the captured image.

Hereinafter, the electronic device **100** according to an exemplary embodiment of the present invention will be described in more detail based on the aforementioned contents.

The storage unit **110** functions to store various data and applications required for an operation of the electronic device **100**. In particular, the storage unit **110** may store data necessary for an operation of the electronic device **100**, e.g., an OS, a route search application, and map data.

In addition, the storage unit **110** may store data generated by an operation of the electronic device **100**, for example, route data searched from a starting point to a destination and a received image.

The storage unit **110** may be implemented as an internal storage element such as a random access memory (RAM), a flash memory, read only memory (ROM), an erasable programmable ROM (EPROM), an electronically erasable and programmable ROM (EEPROM), a register, a hard disk, a removable disk, a memory card, a universal subscriber identity module (USIM), and a detachable storage element such as a USB memory or the like.

The input unit **120** functions to convert a physical input from the outside of the electronic device **100** into a specific electric signal. Here, the input unit **120** may include all or some of the user input unit **121** and the microphone unit **123**.

The user input unit **121** may receive a user input such as a touch or a push operation. Here, the user input unit **121** may be implemented using at least one of various button types, a touch sensor receiving a touch input, and a proximity sensor receiving an approaching motion.

The microphone unit **123** may receive a user's voice and a sound generated inside and outside the vehicle.

The output unit **130** is a device that outputs data of the electronic device **100** to a user as an image and/or audio. Here, the output unit **130** may include all or some of the display unit **131** and the audio output unit **133**.

The display unit **131** is a device outputting data that may be visually recognized by a user. The display unit **131** may be implemented as a display unit provided on the front of a housing of the electronic device **100**. In addition, the display unit **131** may be integrally formed with the electronic device **100** to output visual recognition data and may be installed separately from the system **100** such as a head-up display (HUD) to output visual recognition data.

The audio output unit **133** is a device outputting data that may be audibly recognized by the electronic device **100**. The audio output unit **133** may be implemented as a speaker expressing, as sound, data to be notified by the user of the electronic device **100**.

The lane marking detecting unit **140** may perform the function of the lane marking recognizing unit **13** described above. The AR processing unit **160** may perform the functions of the AR processing devices **10** and **20** described above. That is, the AR processing unit **160** may generate an AR image displaying a driving image captured by the camera and various objects in an overlapping manner.

Meanwhile, the communication unit **180** may be provided for the electronic device **100** to communicate with other devices. The communication unit **180** may include all or some of a position data unit **181**, a wireless Internet unit **183**, a broadcast transceiver unit **185**, a mobile communication unit **186**, a short-range communication unit **187**, and a wired communication unit **189**.

The position data unit **181** refers to a device that acquires position data through a global navigation satellite system (GNSS). GNSS refers to a navigation system capable of calculating a position of a receiving terminal using radio signals received from satellites. Specific examples of GNSS include global positioning system (GPS), Galileo, global orbiting navigational satellite system (GLONASS), COMPASS, Indian regional navigational satellite system (IRNSS), quasi-zenith satellite system (QZSS), etc. According to operators. The position data unit **181** of the system according to an exemplary embodiment of the present invention may acquire position data upon receiving a GNSS signal provided in a region in which the electronic device **100** is used. Alternatively, the position data unit **181** may acquire position data through communication with a base station or an access point (AP) in addition to the GNSS.

The wireless Internet unit **183** is a device that acquires or transmits data by accessing the wireless Internet. The wireless internet unit **183** may access the Internet through various communication protocols defined to perform wireless data transmission and reception of wireless LAN (WLAN), wireless broadband (Wibro), world interoperability for microwave access (Wimax), and high speed downlink packet access (HSDPA).

The broadcast transceiver unit **185** is a device that transmits and receives broadcast signals through various broadcast systems. Broadcast systems that may transmit and receive through the broadcast transceiver unit **185** include digital multimedia broadcasting terrestrial (DMBT), digital multimedia broadcasting satellite (DMBS), media forward link only (MediaFLO), digital video broadcast handheld (DVBH), and integrated services digital broadcast terrestrial (ISDBT). Broadcast signals transmitted and received through the broadcast transceiver unit **185** may include traffic data, life data, and the like.

The mobile communication unit **186** may perform voice and data communication by accessing a mobile communication network according to various mobile communication standards such as 3rd generation (3G), 3rd generation partnership project (3GPP), and long term evolution (LTE).

The short-range communication unit **187** is a device for short-range communication. As described above, the short-range communication unit **187** performs communication through Bluetooth, radio frequency identification (RFID), infrared data association (IrDA), ultra wideband (UWB), ZigBee, near field communication (NFC), wireless-fidelity (Wi-Fi), etc.

The wired communication unit **189** is an interface device capable of connecting the electronic device **100** to another device by wire. The wired communication unit **189** may be a USB module capable of communicating through a USB port.

The communication unit **180** may communicate with another device using at least one of the position data unit **181**, the wireless Internet unit **183**, a broadcast transceiver unit **185**, the mobile communication unit **186**, the short-range communication unit **187**, and the wired communication unit **189**.

As an example, when the electronic device **100** does not include a camera function, an image captured by an imaging device for a vehicle such as a car dash cam or a car video recorder may be received using at least one of the short-range communication unit **187** and the wired communication unit **189**.

As another example, in the case of communicating with a plurality of devices, one thereof may communicate with the short-range communication unit **187** and the other may communicate with the wired communication unit **119**.

The sensing unit **190** is a device capable of detecting a current state of the electronic device **100**. The sensing unit **190** may include all or some of a motion sensing unit **191** and a light sensing unit **193**.

The motion sensing unit **191** may detect a motion of the electronic device **100** in a 3D space. The motion sensing unit **191** may include a 3-axis geomagnetic sensor and a 3-axis acceleration sensor. A trace of the vehicle to which the electronic device **100** is attached may be more accurately calculated by combining motion data acquired through the motion sensing unit **191** with position data acquired through the position data unit **181**.

The light sensing unit **193** is a device that measures ambient illuminance of the system **100**. Brightness of the display unit **131** may be changed to correspond to ambient brightness using illuminance data acquired through the light sensing unit **193**.

The power supply unit **195** is a device that supplies power necessary for an operation of the electronic device **100** or an operation of another device connected to the electronic device **100**. The power supply unit **195** may be a device that receives power from a battery built in the electronic device **100** or an external power source of a vehicle. In addition, the power supply unit **195** may be implemented as the wired communication module **119** or may be implemented as a device supplied wirelessly according to a type of receiving power.

The controller **170** controls an overall operation of the electronic device **100**. Specifically, the controller **170** may control all or some of the storage unit **110**, the input unit **120**, the output unit **130**, the AR processing unit **160**, the communication unit **180**, the sensing unit **190**, and the power supply unit **195**.

That is, the controller **170** may control the AR processing unit **160** based on a predetermined condition (e.g., the driving environment of the vehicle and/or a user input through the input unit **120**) to display an AR image matching certain conditions on the display unit **131**.

As an example, when a request for route guidance to a destination is input from the user through the input unit **120**, the controller **170** may control the AR processing unit **160** to generate an AR image in which a captured driving image and a route guidance object are displayed in an overlapping manner, and control the display unit **131** to display the generated AR image.

FIG. **11** is a view illustrating a system network connected to an electronic device according to an exemplary embodiment of the present invention. Referring to FIG. **11**, an electronic device **100** according to an exemplary embodiment of the present invention may be implemented as various devices provided in a vehicle such as a navigation device, an imaging device for a vehicle, a smartphone, or other device for providing an AR interface for a vehicle, and may be connected to various communication networks and other electronic devices **61** to **64**.

In addition, the electronic device **100** may calculate a current position and a current time zone by interworking with a GPS module according to a radio signal received from a satellite **20**.

Each satellite **20** may transmit an L-band frequency having a different frequency band. The device **100** may calculate a current position based on a time taken for the L-band frequency transmitted from each satellite **20** to reach the electronic device **100**.

Meanwhile, the electronic device **100** may wirelessly access a network **30** through a control station (ACR) **50**, a base station (RAS) **50**, an access point (AP), etc. via the communication unit **180**. When the electronic device **100** is connected to the network **30**, the electronic device **100** may be indirectly connected with other electronic devices **61** and **62** connected to the network **30**, to exchange data.

Meanwhile, the electronic device **100** may indirectly access the network **30** through another device **63** having a communication function. For example, when a module capable of accessing the network **30** is not provided in the electronic device **100**, the electronic device **100** may communicate with another device **63** having a communication function through a short-range communication module or the like.

Hereinafter, an AR processing method according to an exemplary embodiment of the present invention will be described in more detail with reference to FIGS. **12** to **13**.

FIG. **12** is a flowchart illustrating a method for generating an AR image according to an exemplary embodiment of the present invention. Referring to FIG. **12**, a driving image captured by an image capturing device of a driving vehicle may be acquired (S**110**). Specifically, in the acquiring operation (S**110**), a driving image captured by the image capturing device installed in the vehicle may be acquired in real time while the vehicle is driving.

Also, route data to a destination of the vehicle may be acquired (S**120**). Specifically, in the acquiring operation (S**120**), route data from the map data to the destination of the vehicle may be acquired. Here, the route data may include link data and node data for indicating a route to the destination of the vehicle, and the link data may include link linear data and link attribute data.

Then, both side lane markings of a lane in which the vehicle is driving may be recognized from the acquired driving image (S**130**). Specifically, the recognizing operation (S**130**) may include detecting an edge corresponding to the lane markings from the acquired driving image, generating an edge image based on the detected edge, detecting a straight line component based on the detected edge, generating an edge straight line processed image based on the

detected straight line component, detecting a lane marking point corresponding to a lane marking using the generated edge image and the edge straight line processed image, and recognizing a lane marking based on the detected lane marking point. That is, in the recognizing operation (S**130**), both side lane markings in which the vehicle is running may be recognized by detecting a lane marking point corresponding to a left lane marking and a lane marking point corresponding to a right lane marking.

In addition, with respect to a region in which both side lane markings are recognized in the driving image, first route guidance linear data may be generated based on the recognized both side lane markings (S**140**). Specifically, in the generating of the first route guidance linear data, a virtual point located in the middle may be determined based on a plurality of points constituting the detected left lane marking and a plurality of points constituting a right lane marking, and first route guidance linear data may be generated by connecting virtual points.

In addition, for a region in which both side lane markings are not recognized in the driving image, second route guidance linear data may be generated using link linear data of the route data (S**150**). Specifically, the generating of the second route guidance linear data (S**150**) may include detecting link linear data corresponding to a region in which both side lane markings are not recognized based on the current position of the vehicle among the plurality of link linear data and generating second route guidance linear data based on the detected link linear data.

Here, the generating of the second route guidance linear data (S**150**) may include correcting a position error and an angle error.

Specifically, the generating of the second route guidance linear data (S**150**) may include calculating translation values of points constituting the link linear data based on a position of a first point constituting the first route guidance linear data and translating the points constituting the link linear data based on the calculated translation value.

In addition, the generating of the second route guidance linear data (S**150**) may further include calculating a rotation angle of the link linear data based on an angle difference between a driving direction vector of the vehicle and a route direction vector of the vehicle and rotating the link linear data according to the translation based on the calculated rotation angle.

According to the generating of the second route guidance linear data (S**150**), second route guidance linear data in which a position error and an angle error are corrected may be generated.

Meanwhile, if only one lane is recognized in the recognizing of a lane marking (S**130**), the method may further include generating a virtual lane marking for the other lane marking based on the lane marking width data, and determining a virtual point located in the middle based on the recognized one lane marking and the other virtual lane marking being virtually generated and generating route guidance linear data by connecting virtual points.

Then, combined route guidance linear data may be generated by combining the first route guidance linear data and the second route guidance linear data (S**160**).

Also, an AR image to which the route guidance object is mapped may be generated based on the generated combined route guidance linear data (S**170**). Here, the route guidance object may include a first route guidance object in the shape of an arrow and second and third route guidance objects in the shape of a carpet. The generating of the AR image (S**170**) will be described in more detail with reference to FIG. **13**.

Meanwhile, the electronic device **100** may further perform displaying of the generated AR image.

FIG. **13** is a flowchart specifically illustrating a linear data generating operation according to an exemplary embodiment of the present invention. Referring to FIG. **13**, a position of the combined route guidance linear data generated in the generating operation (**S160**) in a virtual 3D space, a position of the left lane marking in the virtual 3D space, and a position of the right lane marking in the virtual 3D space may be calculated (**S210**).

Also, a mapping position of the first route guidance object may be determined so that the center of the first route guidance object is located at the position of the combined route guidance linear data in the virtual 3D space (**S220**).

Also, a mapping position of the second route guidance object may be determined between the position of the left lane marking in the virtual 3D space and the position of the first route guidance object in the virtual 3D space (**S230**).

Also, a mapping position of the third route guidance object may be determined between the position of the right lane marking in the virtual 3D space and the position of the first route guidance object in the virtual 3D space (**S240**).

Also, virtual 3D spatial data mapped to the determined mapping positions of each of the first route guidance object, the second route guidance object, and the third route guidance object may be generated (**S250**).

Also, virtual 3D spatial data to which the route guidance objects are mapped may be converted into a 2D image to generate an AR image using a camera matrix (**S260**). Accordingly, the image captured by the camera and the route guidance object may be displayed in an overlapping manner in the AR image.

Meanwhile, the AR image generating method according to an exemplary embodiment of the present invention may further include curving at least one of the both side lane markings recognized by the lane marking recognizing unit **13**, the first route guidance linear data, and the second route guidance linear data.

Also, the method for generating an AR image according to an exemplary embodiment of the present invention may further include performing a filtering process on spatial coordinates in calculated 3D space during the operation of the device.

FIG. **14** is a view illustrating an AR image displayed through an electronic device when route guidance to a destination is performed. Referring to FIG. **14**, the display unit **131** of the electronic device **100** may display an AR image **1300** in which a driving image **1301** captured by a camera and route guidance objects **1302**, **1303**, and **1304** are overlapped.

The AR image **1300** is an AR image at a first time point, and the AR image **1320** is an AR image at a second view point after a predetermined time from the first time point.

The AR images **1300** and **1320** may include images of a front vehicle driving in front of the vehicle.

In addition, the route guidance object may include a first route guidance object **1302** displayed in an arrow shape on a lane in which the vehicle is running, a second route guidance object **1303** displayed in a rectangular shape on a lane in which the vehicle is running, and a third route guidance object **1304** displayed in a rectangular shape on a lane in which the vehicle is running.

Here, the first route guidance object **1302** may be arranged based on the combined route guidance linear data generated by the route guidance linear data generating unit **14** and displayed on the AR image **1300**. In addition, the second route guidance object **1303** may be displayed

between the left of the first route guidance object **1302** and a left lane marking and displayed through AR, and the third route guidance object **1304** may be disposed between the right of the first route guidance object **1302** and a right lane marking and displayed through AR.

Here, the second route guidance object **1303** and the third route guidance object **1304** may have transparency toward from the outside to the inside.

Meanwhile, the route guidance objects **1302**, **1303**, and **1304** may be displayed by moving from front to rear when the vehicle travels forward. That is, a first route guidance object **1310-1** displayed in the front of the vehicle in the AR image **1300** in a first view may be displayed **1310-1** to be closer to the vehicle in an AR image **1320** in a second view in which the vehicle has traveled to the front for a predetermined period of time. Also, a moving speed of the route guidance objects **1302**, **1303**, and **1304** may vary according to a driving speed of the vehicle.

The route guidance objects **1302**, **1303**, and **1304** may be displayed in blue, and the color may change or disappear under a certain condition. For example, the certain condition in which the color of the route guidance objects **1302**, **1303**, and **1304** changes may be a condition in which the vehicle deviates from a lane marking, and the certain condition in which the route guidance objects **1302**, **1303** and **1304** disappear may be a condition in which the vehicle is close to a turn point.

According to the present invention, the first route guidance object **1302** based on a lane is moved through animation processing according to a vehicle speed, so that the object may be expressed naturally and dynamically as if it is painted on the lane.

FIG. **15** is a view illustrating an AR image displayed through an electronic device when a vehicle deviates from a lane marking. An AR image **1410** is an image displayed on the electronic device **100** when a distance to a front vehicle located in front of the vehicle is narrowed to within a predetermined distance during route guidance, and an AR image **1420** is an image displayed on the electronic device **100** when the vehicle deviates from the lane marking after a predetermined period of time from the image **1410**.

The display unit **131** of the electronic device **100** may display AR images **1410** and **1420** in which the driving image **1401** captured by the camera and the route guidance objects **1402**, **1403**, and **1404** are superimposed.

First, when a distance to a front vehicle located in front of the vehicle is reduced to within a predetermined distance during route guidance, the electronic device **100** may display an AR image **1410** including route guidance objects **1402**, **1403**, and **1404** and a front vehicle collision avoidance guidance object **1405**. Here, the front vehicle collision avoidance guidance object **1405** may be displayed in an image region of the front vehicle and may display a collision time with the front vehicle.

Thereafter, when the vehicle deviates from the lane marking, the electronic device **100** may change and display a display state of at least one of the second route guidance object **1403** and the third route guidance object **1404**. Specifically, the electronic device **100** may change colors of the second route guidance object **1403** and the third route guidance object **1404** from blue to red, and blinks the third route guidance object **1404** corresponding to the lane marking from which the vehicle deviates. The third route guidance object **1404** is not displayed in the AR image **1420** because it is an image captured in an OFF state changed from an ON state.

Meanwhile, in this case, the color of the first route guidance object **1402** may be maintained as blue.

In addition, the electronic device **100** may display an AR image **1420** including a lane departure guidance object **1406** corresponding to the lane marking from which the vehicle deviates.

FIGS. **16** to **17** are views illustrating AR images displayed through an electronic device when a vehicle approaches a turn point. Referring to FIGS. **16** to **17**, when the vehicle approaches a turn point (U-turn, left turn, right turn, etc.) where the vehicle needs to change a driving direction, the electronic device **100** may delete the route guidance object and display an AR image including only a turn point guidance object. Here, the turn point guidance object may include a first turn point guidance object **1501** that guides a driving direction at the turn point with vertically arranged arrows and a second turn point guidance object **1502** that guides the driving direction at the turn point with an animation bouncing up and down.

For example, when the vehicle approaches the U-turn point, the electronic device **100** may display the AR image **1510**. Also, when the vehicle approaches a left turn point, the electronic device **100** may display an AR image **1520**, **1530**, or **1540** according to the left turn direction. Also, when the vehicle approaches a right turn point, the electronic device **100** may display an AR image **1610**, **1620**, or **1630** according to the left turn direction.

According to the present invention, when the vehicle approaches the turn point, the route guidance object may be deleted and the turn point guidance object may be displayed, so that the user may clearly recognize the turn point information.

FIG. **18** is a view illustrating an implementation form when an electronic device according to an exemplary embodiment of the present invention does not include an imaging unit. Referring to FIG. **18**, an image recording device **200** for a vehicle provided separately from the electronic device **100** for a vehicle may configure a system according to an exemplary embodiment of the present invention using a wired/wireless communication method.

The electronic device **100** for a vehicle may include a display unit **131** provided on a front surface of a housing **191**, an operation key **121**, and a microphone **123**.

The image recording device **200** for a vehicle may include a camera **222** as an image acquiring device, a microphone **224**, and an attaching part **281**.

FIG. **19** is a view illustrating an implementation form when an electronic device according to an exemplary embodiment of the present invention includes an imaging unit. Referring to FIG. **19**, when the electronic device **100** includes an imaging unit **150**, the imaging unit **150** of the electronic device **100** may image a front of a vehicle and a display part of the electronic device **100** may allow the user to recognize the image. Accordingly, a system according to an exemplary embodiment of the present invention may be implemented.

FIG. **20** is a diagram illustrating an implementation form using a head-up display (HUD) according to an exemplary embodiment of the present invention. Referring to FIG. **20**, the HUD may display an AR guidance screen on a head-up display through wired/wireless communication with other devices.

For example, the AR may be provided through a HUD using a vehicle windshield or image overlay using a separate image output device, and the AR processing unit **160** may generate an interface image overlaid on a real image or

glass. Through this, an AR navigation or vehicle infotainment system may be implemented.

According to the various exemplary embodiments of the present invention described so far, a route guidance object may be displayed based on the result of recognizing the lane markings on both sides of a lane in which the vehicle is running, and in case of a long distance where a lane marking is deleted or not visible, a route guidance object may be displayed using route data stored in the storage unit, thereby more accurately display the route guidance object on the AR.

Also, according to various exemplary embodiments of the present disclosure, a dynamic route guidance object that the driver may intuitively recognize may be displayed on the AR.

In addition, according to various exemplary embodiments of the present disclosure, when a lane departure occurs while the vehicle is running, the route guidance object and the lane departure guidance object may be intuitively displayed on the AR.

Meanwhile, at least one or more of the modules constituting the AR processing device **10** and the electronic device **100** according to the present invention may be implemented as one module of a system for autonomous driving to perform a route guidance function. This will be described in more detail with reference to FIGS. **21** and **22**.

Referring to FIG. **21**, an autonomous vehicle **2000** according to the present exemplary embodiment includes a control device **2100**, sensing modules **2004a**, **2004b**, **2004c**, and **2004d**, an engine **2006**, and a user interface **2008**.

The autonomous vehicle **2000** may have an autonomous driving mode or a manual mode. For example, the autonomous vehicle **2000** may be switched from the manual mode to the autonomous driving mode or from the autonomous driving mode to the manual mode according to a user input received through the user interface **2008**.

When the vehicle **2000** is operated in the autonomous driving mode, the autonomous vehicle **2000** may be operated under the control of the control device **2100**.

In this exemplary embodiment, the control device **2100** may include a controller **2120** including a memory **2122** and a processor **2124**, a sensor **2110**, a communication device **2130**, and an object detecting device **2140**.

In this exemplary embodiment, the object detecting device **2140** is a device for detecting an object located outside the vehicle **2000**, and the object detecting device **2140** may detect an object located outside the vehicle **2000** and generate object information according to a detection result.

The object information may include information on the presence or absence of an object, position information of the object, distance information between the vehicle and the object, and relative speed information between the vehicle and the object.

The object may include various objects located outside the vehicle **2000** such as lane markings, other vehicles, pedestrians, traffic signals, light, roads, structures, speed bumps, terrain objects, animals, and the like. Here, the traffic signal may be a concept including a traffic light, a traffic sign, or a pattern or text drawn on a road surface. In addition, light may be light generated from a lamp provided in another vehicle, light generated from a street lamp, or sunlight.

The structure may be an object located around a road and fixed to the ground. For example, the structure may include street lights, street trees, buildings, power poles, traffic lights, and bridges. The terrain objects may include mountains, hills, and the like.

The object detecting device **2140** may include a camera module. The controller **2120** may extract object information from an external image captured by the camera module and cause the controller **2120** to process the information.

In addition, the object detecting device **2140** may further include imaging devices for recognizing an external environment. In addition to LIDAR, RADAR, GPS device, odometry, and other computer vision devices, ultrasonic sensors, and infrared sensors may be used, and these devices may be selectively or simultaneously operated as necessary to enable more precise detection.

In addition, the sensor **2110** may be connected to the sensing modules **2004a**, **2004b**, **2004c**, and **2004d** to acquire various kinds of sensing information on a vehicle internal/external environment. Here, the sensor **2110** may include a posture sensor (e.g., a yaw sensor, a roll sensor, or a pitch sensor), a collision sensor, a wheel sensor, a speed sensor, an inclination sensor, a weight detection sensor, a heading sensor, a gyro sensor, a position module, a vehicle forward/reverse sensor, a battery sensor, a fuel sensor, a tire sensor, a steering sensor based on handle rotation, a vehicle internal temperature sensor, a vehicle internal humidity sensor, an ultrasonic sensor, an illuminance sensor, an accelerator pedal position sensor, a brake pedal position sensor, and the like.

Accordingly, the sensor **2110** may acquire vehicle posture information, vehicle collision information, vehicle direction information, vehicle position information (GPS information), vehicle angle information, vehicle speed information, vehicle acceleration information, vehicle inclination information, vehicle advance/reverse information, battery information, fuel information, tire information, vehicle lamp information, vehicle internal temperature information, vehicle internal humidity information, steering wheel rotation angle, vehicle external illumination, and a sensing signal for pressure applied to an accelerator pedal, pressure applied to a brake pedal, etc.

In addition, the sensor **2110** may further include an accelerator pedal sensor, a pressure sensor, an engine speed sensor, air flow sensor (AFS), an intake air temperature sensor (ATS), water temperature sensor (WTS), a throttle position sensor (TPS), a TDC sensor, a crank angle sensor (CAS), and the like.

In this manner, the sensor **2110** may generate vehicle state information based on sensing data.

The wireless communication device **2130** is configured to implement wireless communication between the autonomous vehicles **2000**. For example, the autonomous vehicle **2000** may communicate with a user's mobile phone, another wireless communication device **2130**, another vehicle, a central device (a traffic control device), a server, and the like. The wireless communication device **2130** may transmit and receive wireless signals according to wireless communication protocols. The wireless communication protocols may be Wi-Fi, Bluetooth, long-term evolution (LTE), code division multiple access (CDMA), wideband code division multiple access (WCDMA), global systems for mobile communications (GSM), but are not limited thereto.

In addition, in the present exemplary embodiment, the autonomous vehicle **2000** may implement vehicle-to-vehicle communication through the wireless communication device **2130**. That is, the wireless communication device **2130** may communicate with another vehicle and other vehicles on the road through vehicle-to-vehicle communication (V2V). The autonomous vehicle **2000** may transmit and receive information such as driving warning and traffic information through V2V communication and may request information

or receive a request from another vehicle. For example, the wireless communication device **2130** may perform V2V communication with a dedicated short-range communication (DSRC) device or a cellular-V2V (C-V2V) device. In addition, in addition to V2V communication, communication between the vehicle and other objects (vehicle to everything communication (V2X)) (e.g., electronic devices carried by pedestrians) may be implemented through the wireless communication device **2130**.

In this exemplary embodiment, the controller **2120** is a unit that controls an overall operation of each unit in the vehicle **2000** and may be configured at the time of manufacturing by a manufacturer of the vehicle or additionally configured to perform a function of autonomous driving after manufacturing. Alternatively, a component for continuously performing an additional function may be included through upgrading of the controller **2120** configured at the time of manufacturing. The controller **2120** may also be referred to as an electronic controller (ECU).

The controller **2120** may collect various data from the connected sensor **2110**, the object detecting device **2140**, the communication device **2130**, etc. And transfer a control signal to other components in the vehicle such as the sensor **2110**, the engine **2006**, the user interface **2008**, the communication device **2130**, and the object detecting device **2140**, based on the collected data. In addition, although not shown, the control signal may also be transmitted to an acceleration device, a braking system, a steering device, or a navigation device related to driving of the vehicle.

In this exemplary embodiment, the controller **2120** may control the engine **2006**. For example, the controller **2120** may detect a speed limit of a road on which the autonomous vehicle **2000** is running and control the engine **2006** so that a driving speed of the vehicle does not exceed the speed limit or control the engine **2006** to accelerate a driving speed of the autonomous vehicle **2000** within a range not exceeding the speed limit.

In addition, if the autonomous vehicle **2000** approaches or leaves a lane marking during driving, the controller **2120** may determine whether such lane marking proximity and/or departure is according to a normal driving situation or whether it is according to other driving conditions, and control the engine **2006** to control driving of the vehicle according to a determination result. Specifically, the autonomous vehicle **2000** may be equipped with a lane marking detecting apparatus **10** according to an exemplary embodiment of the present invention, and the lane marking detecting apparatus **10** may detect lane markings formed on both sides of a lane in which the vehicle is running. In this case, the controller **2120** may determine whether the autonomous vehicle **2000** is approaching or leaving the lane marking, and if it is determined that the autonomous vehicle **2000** is approaching or leaving the lane marking, the controller **2120** may determine whether such driving is based on an accurate driving situation or other driving situations. Here, an example of a normal driving situation may be a situation in which the vehicle needs to change lanes. In addition, an example of other driving situations may be a situation in which the vehicle does not need to change lanes. If it is determined that the autonomous vehicle **2000** is approaching or leaving the lane marking in a situation in which the vehicle does not need to change lanes, the controller **2120** may control the autonomous vehicle **2000** to normally run without departing the lane marking.

The lane marking detecting apparatus **10** may be configured as a module in the control device **2100** of the autonomous vehicle **2000**. That is, the memory **2122** and the

processor **2124** of the control device **2100** may implement the lane detecting method according to the present invention in software.

When another vehicle or an obstacle is present in front of the vehicle, the controller **2120** may control the engine **2006** or a braking system to decelerate the driving vehicle, and may control a trace, a driving route, and a steering angle, in addition to the speed. Alternatively, the controller **2120** may control the driving of the vehicle by generating a necessary control signal according to recognition information of other external environments such as a lane of the driving vehicle and a driving signal.

In addition to generating a control signal of its own, the controller **2120** may perform communication with a nearby vehicle or a central server and transmit a command to control peripheral devices through received information, thereby controlling the driving of the vehicle.

In addition, it may be difficult to accurately recognize a vehicle or a lane marking if a position of the camera module is changed or an angle of view is changed. In order to prevent this, the controller **2120** may generate a control signal to perform calibration of the camera module. Accordingly, in this exemplary embodiment, since the controller **2120** generates a calibration control signal to the camera module, even if a mounting position of the camera module is changed due to vibration or impact that occurs due to movement of the autonomous vehicle **2000**, a normal mounting position, direction, and angle of view of the camera module may be continuously maintained. If an initial mounting position, direction, and angle of view information of the camera module stored in advance and an initial mounting position, direction, and angle of view information of the camera module measured during the driving of the autonomous vehicle **2000** are changed by a threshold value or more, the controller **2120** may generate a control signal to calibrate the camera module.

In this exemplary embodiment, the controller **2120** may include the memory **2122** and the processor **2124**. The processor **2124** may execute software stored in the memory **2122** according to a control signal from the controller **2120**. Specifically, the controller **2120** may store data and instructions for performing the lane marking detecting method according to the present invention in the memory **2122**, and the instructions may be executed by the processor **2124** to implement one or more methods disclosed herein.

In this case, the memory **2122** may be stored in a recording medium executable by the nonvolatile processor **2124**. The memory **2122** may store software and data through an appropriate internal or external device. The memory **2122** may be configured as a memory device connected to a random access memory (RAM), a read only memory (ROM), a hard disk, and a dongle.

The memory **2122** may store at least an operating system (OS), a user application, and executable instructions. The memory **2122** may also store application data and array data structures.

The processor **2124**, as a microprocessor or a suitable electronic processor, may be a controller, a microcontroller, or a state machine.

The processor **2124** may be implemented as a combination of computing devices, and the computing device may be configured as a digital signal processor, a microprocessor, or a suitable combination thereof.

Meanwhile, the autonomous vehicle **2000** may further include the user interface **2008** for user inputting for the control device **2100** described above. The user interface **2008** may allow a user to input information through appro-

priate interaction. For example, the user interface **2008** may be implemented as a touch screen, a keypad, and an operation button. The user interface **2008** may transmit an input or command to the controller **2120**, and the controller **2120** may perform a vehicle control operation in response to the input or command.

In addition, the user interface **2008** may allow a device outside the autonomous vehicle **2000** to communicate with the autonomous vehicle **2000** through the wireless communication device **2130**. For example, the user interface **2008** may interwork with a mobile phone, a tablet, or other computer devices.

Furthermore, in the present exemplary embodiment, the autonomous vehicle **2000** has been described as including the engine **2006**, but the autonomous vehicle **2000** may include other types of propulsion systems. For example, a vehicle may be driven by electric energy and may be driven by hydrogen energy or a hybrid system combining them. Accordingly, the controller **2120** may include a propulsion mechanism according to a propulsion system of the autonomous vehicle **2000** and provide a control signal according to the propulsion system to components of each propulsion mechanism.

Hereinafter, a detailed configuration of the control device **2100** for performing the lane marking detecting method according to a present exemplary embodiment will be described in more detail with reference to FIG. **22**.

The control device **2100** includes a processor **2124**. The processor **2124** may be a general purpose single or multi-chip microprocessor, a dedicated microprocessor, a microcontroller, a programmable gate array, or the like. The processor may also be referred to as a central processing unit (CPU). In addition, in the present exemplary embodiment, the processor **2124** may be used as a combination of a plurality of processors.

The control device **2100** also includes the memory **2122**. The memory **2122** may be any electronic component capable of storing electronic information. The memory **2122** may also include a combination of memories **2122** in addition to a single memory.

Data and instructions **2122a** for performing the lane marking detecting method according to the present invention may be stored in the memory **2122**. When the processor **2124** executes the instructions **2122a**, all or some of the instructions **2122a** and data **2122b** required for execution of the instructions **2124a** and **2124b** may be loaded onto the processor **2124**.

The control device **2100** may include a transmitter **2130a**, a receiver **2130b**, or a transceiver **2130c** for allowing transmission and reception of signals. One or more antennas **2132a** and **2132b** may be electrically connected to the transmitter **2130a**, the receiver **2130b**, or each transceiver **2130c**, and may additionally include antennas.

The control device **2100** may include a digital signal processor (DSP) **2170**. A digital signal may be quickly processed by the vehicle through the DSP **2170**.

The control device **2100** may also include a communication interface **2180**. The communication interface **2180** may include one or more ports and/or communication modules for connecting other devices to the control device **2100**. The communication interface **2180** may allow a user and the control device **2100** to interact with each other.

Various components of the control device **2100** may be connected together by one or more buses **2190**, and the buses **2190** may include a power bus, a control signal bus, a state signal bus, a data bus, and the like. Under the control

of the processor 2124, the components may transmit mutual information through the bus 2190 and perform a desired function.

According to various exemplary embodiments of the present disclosure, a route guidance object may be displayed based on the result of recognizing the lane markings on both sides of a driving lane of a vehicle, and at a long distance where the lane is not erased or not visible, a route guidance object is displayed using route data stored in a storage unit, thereby more accurately displaying a route guidance object on an AR.

According to various exemplary embodiments of the present disclosure, a dynamic route guidance object that a driver may intuitively recognize may be displayed on AR.

According to various exemplary embodiments of the present disclosure, when a lane departure occurs while driving a vehicle, a route guidance object and a lane departure guidance object may be intuitively displayed on the AR.

Meanwhile, in the specification and the claims, terms such as “first”, “second”, “third”, “fourth”, and the like, if any, will be used to distinguish similar components from each other and be used to describe a specific sequence or a generation sequence, but is not necessarily limited thereto. The terms used as such will be understood by the exemplary embodiments of the invention described herein. Likewise, in the case in which it is described herein that a method includes a series of steps, a sequence of the steps suggested herein is not necessarily a sequence in which the steps may be executed, and any described step may be omitted and/or any other steps that are not described herein may be added to the method. For example, the first component may be referred to as a second component, and similarly, the second component may be referred to as a first component, without departing from the scope of the present invention.

In addition, in the specification and the claims, terms such as “left”, “right”, “front”, “rear”, “top”, “bottom”, “over”, “under”, and the like do not necessarily indicate relative positions that are not changed, but are used for explanation. It will be understood that these terms are compatible with each other under an appropriate environment so that exemplary embodiments of the present invention set forth herein may be operated in a direction different from a direction illustrated or described herein. The term “connected” as used herein is defined as being connected directly or indirectly in an electrical or non-electrical manner. Here, targets described as being “adjacent to” each other may physically contact each other, be close to each other, or be in the same general range or region, in a context in which the above phrase is used. Here, the presence of phrase “in an exemplary embodiment” means the same exemplary embodiment, but is not necessarily limited thereto.

In addition, in the specification and the claims, terms such as “connected”, “connecting”, “linked”, “linking”, “coupled”, “coupling”, and the like, and various modifications of these terms may be used as the meaning including that one component is directly connected to another component or is indirectly connected to another component through the other component.

Meanwhile, when it is mentioned that any component is “directly coupled” or “directly connected” to another component, it is to be understood that any component may be coupled or connected to the other element without another component interposed therebetween.

In addition, terms “module” and “unit” for components used in the present specification are used only in order to

easily make the specification. Therefore, these terms do not have meanings or roles that distinguish from each other in themselves.

In addition, the terms used in the present specification are for explaining exemplary embodiments rather than limiting the present invention. The singular expression used in the present specification includes the plural expression unless the context clearly indicates otherwise. In the specification, it is to be noted that the terms “comprising” or “including”, and the like, are not to be construed as necessarily including several components or several steps described in the specification and some of the above components or steps may not be included or additional components or steps are construed as being further included.

Hereinabove, the present invention has been described with reference to the exemplary embodiments thereof. All exemplary embodiments and conditional illustrations disclosed in the present specification have been described to intend to assist in the understanding of the principle and the concept of the present invention by those skilled in the art to which the present invention pertains. Therefore, it will be understood by those skilled in the art to which the present invention pertains that the present invention may be implemented in modified forms without departing from the spirit and scope of the present invention.

Therefore, the exemplary embodiments disclosed herein should be considered in an illustrative aspect rather than a restrictive aspect. The scope of the present invention is shown in the claims rather than the foregoing description, and all differences within the equivalent range should be interpreted as being included in the present invention.

Meanwhile, the method according to various exemplary embodiments of the present invention described above may be implemented as programs and be provided to servers or devices. Therefore, the respective apparatuses may access the servers or the devices in which the programs are stored to download the programs.

In addition, the method according to various exemplary embodiments of the present invention described above may be implemented as a program and stored in various non-transitory computer readable media and provided. The non-transitory computer readable medium is not a medium that stores data for a short time such as a register, a cache, a memory, or the like, but means a machine readable medium that semi-permanently stores data. Specifically, various applications or programs described above may be stored and provided in the non-transitory computer readable medium such as a compact disk (CD), a digital versatile disk (DVD), a hard disk, a Blu-ray disk, a universal serial bus (USB), a memory card, a read only memory (ROM), or the like.

Although the exemplary embodiments of the present invention have been illustrated and described hereinabove, the present invention is not limited to the specific exemplary embodiments described above, but may be variously modified by those skilled in the art to which the present invention pertains without departing from the scope and spirit of the present invention as claimed in the claims. These modifications should also be understood to fall within the technical spirit and scope of the present invention.

What is claimed is:

1. An augmented reality (AR)-based route guidance method using a processor, the AR-based route guidance method comprising:
 - acquiring a driving image captured by an image capturing device of a vehicle which is running;
 - acquiring route data to a destination of the vehicle;

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recognizing both side lane markings of a lane in which the vehicle is running from the acquired driving image; generating first route guidance linear data based on the recognized both side lane markings for a region in which the both side lane markings are recognized in the driving image; 5
generating second route guidance linear data using link linear data of the route data for a region in which the both side lane markings are not recognized in the driving image; 10
combining the first route guidance linear data and the second route guidance linear data to generate combined route guidance linear data; and
displaying a route guidance object in AR image by determining a mapping position of the route guidance object based on the generated combined route guidance linear data, 15
wherein the generating the second route guidance linear data includes detecting the link linear data corresponding to a region in which the both side lane markings are not recognized based on a current position of the vehicle among a plurality of link linear data and generating the second route guidance linear data based on the detected link linear data. 20

2. The AR-based route guidance method of claim 1, wherein the generating of the second route guidance linear data includes: 25
calculating a translation value of points constituting the link linear data based on a position of a first point constituting the first route guidance linear data; and translating points constituting the link linear data based on the calculated translation value. 30

3. The AR-based route guidance method of claim 2, wherein the generating of the second route guidance linear data further includes: 35
calculating a rotation angle of the link linear data based on a difference in angle between a driving direction vector of the vehicle and a route direction vector of the vehicle; and rotating the link linear data according to translation based on the calculated rotation angle. 40 45

4. The AR-based route guidance method of claim 1, further comprising: 45
when only one side lane marking is recognized in the driving image, generating a virtual lane marking for the other side lane marking based on lane marking width data. 50

5. The AR-based route guidance method of claim 1, wherein the route guidance object includes: 55
a first route guidance object having a center in the combined route guidance linear data and having an arrow shape indicating a route along which the vehicle is to run; 60
a second route guidance object indicated between a left side of the first route guidance object and a left lane marking; and
a third route guidance object indicated between a right side of the first route guidance object and a right lane marking. 65

6. The AR-based route guidance method of claim 5, further comprising:

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when the vehicle leaves a lane marking, changing and displaying a display state of at least one of the second route guidance object and the third route guidance object.

7. The AR-based route guidance method of claim 1, wherein the route guidance object is displayed to move from the front to the rear when the vehicle is running forwards, and a movement speed of the route guidance object varies according to a speed of the vehicle.

8. The AR-based route guidance method of claim 1, further comprising: when the vehicle approaches a turn point, displaying a turn point guidance object, without displaying the route guidance object.

9. A program stored in a computer-readable recording medium including a program code for performing the augmented reality (AR)-based route guidance method of claim 1.

10. A computer-readable recording medium storing a program for performing the augmented reality (AR)-based route guidance method of claim 1.

11. An electronic device for performing augmented reality (AR)-based route guidance, the electronic device comprising: 25
a display unit configured to display a screen;
a driving image acquiring unit configured to acquire a driving image captured by an image capturing device of a vehicle which is running;
a route data acquiring unit configured to acquire route data to a destination of the vehicle;
a lane marking recognizing unit configured to recognize both side lane markings of a lane in which the vehicle is running from the acquired driving image;
a route guidance linear data generating unit configured to generate first route guidance linear data based on the recognized the both side lane markings for a region in which the both side lane markings are recognized in the driving image, generate second route guidance linear data using link linear data of the route data for a region in which the both side lane markings are not recognized in the driving image, and generate a combined route guidance linear data by coupling the first route guidance linear data and the second route guidance linear data; and
a controller configured to control the display unit to display a route guidance object on an AR image by determining a mapping position of the route guidance object based on the generated combined route guidance linear data, 30
wherein the route guidance linear data generating unit generates the second route guidance linear data by detecting the link linear data corresponding to a region in which the both side lane markings are not recognized based on a current position of the vehicle among a plurality of link linear data and generates the second route guidance linear data based on the detected link linear data. 35

12. The electronic device of claim 11, wherein the route guidance object includes: 40
a first route guidance object having a center in the combined route guidance linear data and having an arrow shape indicating a route along which the vehicle is to run; 45
a second route guidance object indicated between a left side of the first route guidance object and a left lane marking; and 50

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a third route guidance object indicated between a right side of the first route guidance object and a right lane marking.

13. The electronic device of claim 12, wherein, when the vehicle leaves a lane marking, the controller controls the display unit to change a display state of at least one of the second route guidance object and the third route guidance object and display the changed display state.

14. The electronic device of claim 11, wherein the route guidance object is moved from the front to the rear and displayed in the AR image, and a movement speed of the route guidance object varies according to a speed of the vehicle.

15. The electronic device of claim 11, wherein the controller controls the display unit to display a turn point guidance object, without displaying the route guidance object, when the vehicle approaches a turn point.

16. An augmented reality (AR) processing device comprising:

a driving image acquiring unit configured to acquire a driving image captured by an image capturing device of a vehicle which is running;

a route data acquiring unit configured to acquire route data to a destination of the vehicle;

a lane marking recognizing unit configured to recognize both side lane markings of a lane in which the vehicle is running from the acquired driving image;

a route guidance linear data generating unit configured to generate first route guidance linear data based on the recognized the both side lane markings for a region in which the both side lane markings are recognized in the driving image, generate second route guidance linear data using link linear data of the route data for a region in which the both side lane markings are not recognized

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in the driving image, and combine the first route guidance linear data and the second route guidance linear data to generate combined route guidance linear data; and

an AR image generating unit configured to generate an AR image by determining a mapping position of the route guidance object based on the generated combined route guidance linear data,

wherein the route guidance linear data generating unit generates the second route guidance linear data by detecting the link linear data corresponding to a region in which the both side lane markings are not recognized based on a current position of the vehicle among a plurality of link linear data and generates the second route guidance linear data based on the detected link linear data.

17. The AR processing device of claim 16, wherein the route guidance linear data generating unit calculates a translation value of points constituting the link linear data based on a position of a first point constituting the first route guidance linear data and translates points constituting the link linear data based on the calculated translation value.

18. The AR processing device of claim 17, wherein the route guidance linear data generating unit calculates a rotation angle of the link linear data based on a difference in angle between a driving direction vector of the vehicle and a route direction vector of the vehicle and rotates the link linear data according to translation based on the calculated rotation angle.

19. The AR processing device of claim 16, wherein, when only one side lane marking is recognized in the driving image, the route guidance linear data generating unit generates a virtual lane marking for the other side lane marking based on lane marking width data.

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